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Bell Telephone MAGAZINE

Bell System Participation in the Work of the A S A
HAROLD S. OSBORNE

Carrier is King • CHARLES M. MAPES

Mr. Gifford Retires

This Country Leads the World in Telephones
ELIZABETH WRENSHALL

Service Aids for Home Owners, Architects, and Builders
ADOLPH F. MICHEL AND T. HUNT CLARK

Some Early Long Distance Lines in the Far West
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A Medium of Suggestion & a Record of Progress

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Leroy A. Wilson, *President;* Carroll O. Bickelhaupt, *Sec.;* Donald R. Belcher, *Treas.*

Who's Who & What's What

in This Issue

AUTHORITATIVE is the word for HAROLD S. OSBORNE'S discussion of the Bell System's participation in the work of the American Standards Association, to their mutual advantage; for his long membership in executive posts in both organizations has brought him unexcelled opportunity to become familiar with that inter-relationship. Joining the American Telephone and Telegraph Company in 1910, in the then Transmission and Protection Department, he was assistant to the transmission and protection engineer from 1914 to 1920, and then transmission engineer until 1939. He was operating results engineer 1939–40, and plant engineer 1940–42. In the latter year he became assistant chief engineer, and since 1943 he has been Chief Engineer of the A. T. and T. Company. For many of those same years he has been closely associated in various capacities with the work of the ASA. He served for several years as chairman of the Standards Council, and is at present vice president of the Association and president of the U. S. National Committee of the International Electrotechnical Commission. Mention of his professional attainments must be limited here to reference to his service on many committees of the A. I. E. E., and as its president in 1942–43, and to his Fellowships in several engineering and scientific organizations. Mr. Osborne has contributed half a dozen articles to the old Bell Telephone Quarterly and to its successor, this MAGAZINE, the most recent being—with John J. Hanselman—"Progress in Extending Bell Rural Telephone Service" in the issue for Winter 1946–47.

COMPARED WITH the project of making two blades of grass grow where but one had grown before, imposing 16 telephone circuits on one pair of wires seems a good deal like magic. It is a kind of magic, which CHARLES M. MAPES is able to explain in non-technical terms even though his daily work involves highly technical matters; for

Harold S. Osborne

Charles M. Mapes

Elizabeth Wrenshall

Adolph F. Michel

T. Hunt Clark

he is transmission engineer of the A. T. & T. Company's O. & E. Department. Joining the Company in 1923, he was concerned for 13 years with the provision and maintenance of central office and station equipment and with related work in connection with buildings. During the next three years he served in Pittsburgh as general plant supervisor of the Bell Telephone Company of Pennsylvania. In 1939 he returned to the O. & E. Department as maintenance engineer, and soon found himself in war—and later post-war—planning. After the war, he was appointed systems engineer and devoted himself to planning matters relating to the development of toll line dialing. He was made plant extension engineer in 1946, and that assignment continued until appointment to his present position early in 1949. Many of the contributions to this MAGAZINE represent collaboration in varying degree, and Mr. Mapes wishes to acknowledge the very able assistance of Harold R. Huntley, a member of his staff, who has been associated with the development of the carrier technique since its early days in the Bell System.

COLLEGE COURSES, extensive travels abroad, and a two-year teaching experience in Rome have given ELIZABETH WRENSHALL a facility in languages which she finds useful in connection with gathering and compiling data for the A. T. and T. Company's bulletin "Telephone Statistics of the World," since a good portion of the incoming reports and correspondence is received in languages other than English. After making translations for the censorship authorities during the war, Miss Wrenshall joined the A. T. and T. Company five years ago, and has been with the Foreign Statistics group in the Chief Statistician's Division of the Comptroller's Department for the past four years.

THE COLLABORATION OF ADOLPH F. MICHEL and T. HUNT CLARK bespeaks the common Engineering and Commercial interest of the O. & E. Department in promoting advance planning for telephone facilities in private homes and larger buildings.

Mr. Michel joined the New York Telephone Company in 1916 as a station inspector, and soon became a repairman. Two years later he moved to Washington as a repairman for the Chesapeake and Potomac Telephone Company, returning the following year to his former position in New York. After nine years in the out-

(*Continued on page 239*)

Lashing a telephone cable to its supporting strand on a pole line which is used jointly with an electric light and power company. This economical arrangement is made safe by the observance of established standards of design and construction. *See the article beginning on the opposite page*

Representatives of the Bell System and of the Independent Companies Are Taking Part in 80 Projects of the American Standards Association of Value to This Industry

Bell System Participation in The Work of the A S A

Harold S. Osborne

"THE COMMITTEE is to be congratulated on reaching full agreement," said the Chairman of the Sectional Committee on Wood Poles. "While we started with many divergent views as to the methods of test, ultimate fiber strengths of various species of timber, and other basic features of the proposed standard specifications and dimensions for wood poles, those differences have now been reconciled. I know that all of the organizations which you represent, telephone companies, power companies, railroads, producers of poles, conservation interests, and others will benefit by the simplification which results from joint agreement on these matters."

This incident is one of many which illustrate the extensive activity under the procedures of the American Standards Association in the development of standards which are of value to the telephone industry. At the present time, representatives of the Bell System and of the independent telephone companies are taking part in work on 80 standards projects of this type. In addition, they are coöperating in many other standards projects which at a later stage will come before the ASA for approval.

This may come as a surprise to those familiar with the very large amount of work carried on within the Bell System in the development of standards for the use of the Bell System companies. Such "internal" standards work is natural and suitable for standards relating specifically to telephone operations or standards for material and equipment used wholly or primarily by the Bell telephone companies.

Projects of Wide Interest

THERE ARE numerous large fields of work within which standards are important to the telephone companies

and also to a wide range of other industrial and operating organizations. To be more specific, let us consider the nature of the 80 current ASA projects in which the Bell System companies are coöperating.

The wood pole is an illustration of this—as indicated in the opening paragraph. Poles are used by power companies, railroads, and other wire-using organizations; and several million poles are used jointly by telephone and power companies. Recently, new standards for wood poles have been developed by the ASA Sectional Committee on "Specifications for Wood Poles," under the chairmanship of Dr. R. H. Colley, of the Bell Telephone Laboratories, which unify the requirements for comparable poles purchased by the various kinds of users. More than twenty organizations, representing those having a principal interest in these standards, are represented on the Committee. From this piece of work telephone companies are enjoying a saving of $50,000 a year on purchases of poles for joint use alone.

IT WAS THIS same Sectional Committee which, during the war, developed suitable specifications for the use of additional types of timber not heretofore widely used. Conspicuous among these were white fir, jack pine, red pine, ponderosa pine, Douglas fir, and western larch. This resulted in increased availability of poles of these new types and greatly helped to meet the requirements of both industry and the armed forces during the war.

A considerable number of the ASA Standards projects in which the Bell System is actively coöperating at present refer to standards for materials. These include standards for copper wire, for electric lamps, for storage batteries, for electrical measuring instruments and electron tubes, for paints, and for lubricants. Many relate to standards for materials important in the manufacture of telephone equipment. They include standards for electrical insulating materials, magnet wire, wire and sheet metal gages, petroleum products and lubricants. They also include standards for iron and steel, for brass, for zinc, for bolts and washers, and other materials. Thirty-three of the current projects may be classed as of this general nature.

Another group of projects relates to safety codes of importance in telephone operation and manufacture, as well as in the operations of other organizations. An important illustration of this is the National Electrical Safety Code, specifying forms of electrical construction which are considered safe for both employees and the public. One part of this voluminous code sets down standards of design and construction for pole lines jointly used by power companies and telephone companies. This code is not only generally used by industry as its guide but is also used in many States as the basis for governmental regulation of the construction of electrical lines.

OTHER PROJECTS of this general nature include the safety code for the construction, care, and use of ladders, the safety code for industrial power trucks, the code for protection against lightning, the National Electrical Code (used by fire underwriters as the basis for the approval of electri-

cal installations), standards for the inspection of motor vehicles, the safety code for industrial sanitation, specifications for accident prevention signs, and standards for accident statistics. This last project is for the standardization of the basis used in reporting accident statistics, so that reports from various industries may be more directly comparable than heretofore. This group also includes standards for linemens' rubber protective equipment, protective occupational clothing and footwear, and allowable concentrations of toxic dusts and gases. Thirteen of the projects in which telephone people are now coöperating are of this general character.

Still other standards relate to manufacturing processes and equipment. Illustrations of this are standardization and unification of screw threads, standards for the zinc coating of iron and steel, standard tests of the adhesion and the aging of vulcanized rubber, standard tests of textiles, classification of materials for tools, fixtures and gauges, and standards for industrial sanitation. Sixteen of the projects are of this general class.

The Bell System purchases thousands of ladders, and the employees who climb them are the safer for the standards of manufacture, care, and use established through the ASA

A large group of standards is concerned with building materials and equipment. This includes requirements for structural steel, for masonry, for plastering, for plumbing, light and ventilation, for coordination of the dimensions of building materials, and for standards for pipe threads. Bell System representatives are cooperating in seven of these projects.

Another group of standards projects relates to definitions, nomenclature, and symbols, standards for graphic representation, and similar broad projects. This includes a project for standards

for drawings and drafting-room practice. Seven of the projects in which Bell telephone men are participating are of this general character.

There are, in addition, a number of miscellaneous projects of interest to telephone people. These include such varied matters as standards for sound recording, for vehicle traffic control, for office machinery and supplies, and for optics. Bell System representatives are working on four of these projects.

Specific Cases

AN EXAMPLE of Bell System participation in a specific standard is our interest in the ASA project covering the construction, care, and use of ladders. Ladders are used for many kinds of work both within and outside the Bell System, and the hazards incident to their use are common to all users. Ladder accidents have occurred which are traceable to faulty construction, faulty care, faulty use. With the objective of reducing these accidents, the United States Bureau of Labor Statistics published for trial in 1923 a tentative standard covering the construction, care, and use of ladders. Pooling the experience of users and manufacturers, a committee under the chairmanship of Mr. H. D. Bender, of the Bell Telephone Laboratories, revised and reissued this standard as a full American Standard in 1935 and again in 1948. In this work, careful consideration was given to minimum requirements for ladder strength and to standard dimensions for lumber stock of woods suitable for use in the construction of wood ladders. Thus there were brought together representatives of the ladder-producing and the ladder-using industries in the formulation of a single standard acceptable to all interests.

In addition to being the basis for the construction, care, and use of wood ladders used by Bell System companies, this American Standard is now recognized by the users and manufacturers of ladders generally, and in those States in which Safety or Labor Departments have issued regulations in this field. Work is now under way to establish corresponding standards for ladders made of light metals such as aluminum and magnesium alloys.

ANOTHER active standarization project is one on Acoustical Measurements and Terminology. Organized in 1932 at the request of the Acoustical Society of America, this project, was inactive during the war, but has recently been reorganized in line with technological developments. The committee is now engaged in formulating a number of standards of terms and definitions used in connection with sound reproduction and recording and the levels of noise which may interfere with satisfactory performance.

The recognition of common terms in handling matters such as the transmission of programs over telephone wires is, of course, of value in our relations with broadcasters, wired music systems, and others. In addition, the committee has under way standards for audiometers for diagnostic purposes by doctors and to assist in determining deficiencies in hearing. Other matters under study include laboratory standards for mi-

crophones used in radio broadcast studios, and the sound absorption and transmission abilities of various types of wall materials, such as those used for telephone booths and between rooms in buildings. Representatives of the telephone industry are participating in the many phases of this project which are important in telephone work.

AMERICAN STANDARDS have an important influence on the manufacturing branch of the Bell System—even to the selection of the raw materials which go into the production of telephone apparatus. One illustration is found in such a commonplace item as sheet metal supplies. Vast quantities of telephone equipment, including such things as relay components, apparatus panels and covers, switchboard parts, and pole-line hardware, are made from stampings of steel, aluminum alloys, and other metals. The standardization of thicknesses for these metal supplies has resulted in important economies not only in the purchase of strip and sheet metal stocks but also in the manufacturing design of apparatus and in processing machinery. In addition, the recent American Standard on Surface Roughness fills a long-felt need for a widely accepted scale of roughness which facilitates the purchase of metal stocks having surface finishes suitable for the various types of telephone apparatus.

The American Standards Association

THE FOCAL POINT in this activity in standardization is the American Standards Association.

The Association came into being thirty-one years ago through the action of five organizations which were very active in the preparation of engineering standards. These organizations, which included four large engineering societies and the American Society for Testing Materials, recognized the need for some better means to coördinate the rapidly developing activities in technical standards. In the electrical field, for example, standards for electrical machinery had been developed by the American Institute of Electrical Engineers and by the National Electrical Manufacturers Association, and standards bearing upon the use of electrical machinery had been developed by the National Electric Light Association. There was an increasing tendency, as this work expanded, for overlapping in scope and for the development of conflicting requirements by different organizations.

A STANDARD IS of value precisely to the extent that it is generally accepted and used by all of the parties concerned. If two rival standards exist in the same field, the value of both of them is greatly impaired. This fact was appreciated by the five societies which joined together in 1918 to form the American Engineering Standards Committee. The name was later changed to American Standards Association.

The fundamental principle on which the American Standards Association is based is that, to merit acceptance as an "American Standard," a standard should represent the consensus of all classes of groups interested in the standard. For example, a standard for a specific product or

material must be generally accepted by both producers and consumers, and by other organizations, such as professional societies, which have a general interest in the standard. In the case of a safety code, those interested may include manufacturing and operating organizations, labor, insurance companies, public authorities, and general interests. The code must represent a consensus of all of such groups if it is to be called an "American Standard."

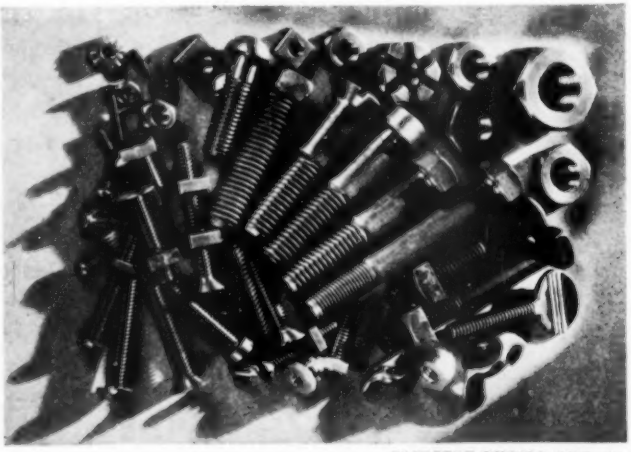
Determining American Standards

THE MAJOR ACTIVITY of the American Standards Association is applying this principle of consensus to standards which are submitted to it for approval as "American Standards."

This process involves determination that all groups directly interested have had an opportunity to take part in the preparation of the standard, that their suggestions have been adequately considered, and that the standard finally adopted has general —although not necessarily unanimous—acceptance.

While the Association does not itself formulate standards, it has developed procedures for use by sponsoring organizations in the formulation of standards. These procedures are designed to insure that the necessary consensus is reached. A procedure widely used is the formation, by the sponsoring organization, of a committee in which all interested groups are represented. This is called a sectional committee. In such cases the whole procedure is approved by the ASA as it develops. The Association approves the scope of the project and the sponsor to whom the project is assigned. It approves the personnel of the sectional committee as adequately representative of all interested groups and suitably balanced in numbers of representatives between different types of interest. Finally, when the committee has recommended and the sponsor has approved a standard, the Association applies the principle of consensus, and approves the standard as an "American Standard."

In some cases, the standards are developed by committees internal to the sponsoring organization and then submitted to ASA for approval as an "American Standard." In such cases the ASA, before approval, determines that a suitable consensus has been reached by coöperation of all interested parties in the prepara-



COURTESY PHEOLL MFG. CO.

Even so prosaic a matter as screw threads has become standardized and is covered by "American Standards"

tion of the standard or by equivalent means.

In addition to this main function of coördinating the standards work of its members and others active in the development of standards in the United States, the ASA has other important activities. It advances the development of standards where the need exists, either by stimulating the work of existing committees or by bringing about the establishment of new committees or organizations for this purpose where they do not already exist. It promotes the knowledge and the use of approved standards and an appreciation of the importance of standards in advancing the national economy.

International Activity

THE ASA also has important international responsibilities. It serves as a clearing house for the interchange of information on standardization work between the United States and foreign countries, and is the authoritative channel for American participation in international standards work.

In carrying out this responsibility, the ASA is a member of the International Organization for Standardization. This is a federation of the national standards bodies of twenty-eight countries, organized to stimulate coöperation and coördination in the development of national standards in those countries. The ASA is also closely related to the International Electrotechnical Commission. This is an international organization representing twenty-two countries which for over forty years has been active in the development of electrical standards and the coördination of national standards in the electrical field. The United States National Committee of the International Electrotechnical Commission, an affiliate of ASA, is the instrument for American participation in this work.

Organization of the ASA

THE CONTROL of the American Standards Association has from the start resided in a single class of members designated as member bodies. A member body must be an organization or group of organizations of national scope interested in standards in a specific field. The first member bodies were the great national engineering societies which formed the American Engineering Standards Committee: i.e., those representing the civil, electrical, mechanical, and mining engineers, and the American Society for Testing Materials. These were soon joined by three Federal departments: Commerce, War, and Navy. The membership has spread so that there are now sixty-four member bodies. Of these, nine are professional societies, and most of the others are trade associations. In addition, there are a number of other organizations, including the National Safety Council and a consumer group, the American Home Economics Association.

A number of the member bodies are groups formed for the purpose of broadly representing an industry in the American Standards Association. This includes the Electric Light and Power Group, consisting of the Edison Electric Institute and the Association of Edison Illuminating Companies. Other examples are the

Fire Protection Group, the Photographic Manufacturers Group, and the Screw Industry Standards Committee.

Telephone Company Representation

THE TELEPHONE COMPANIES of the country are represented in the ASA by a similar member body called the Telephone Group. This consists of the Bell Telephone System and the United States Independent Telephone Association. While the chief function of the Telephone Group is representation of the telephone companies in the ASA, it also provides the basis for representing all telephone companies in some other organizations.

THERE ARE TWO OTHER forms of membership which share in the support but not in the control of the Association. Associate members consist of organizations similar in character to the member bodies and other organizations which may be regional rather than national in scope. Company members are corporations which recognize the importance of the ASA work. The main financial support of the Association is from payments by company members.

Throughout the entire history of the American Standards Association, and until the past two years, there has been active coöperation by the departments of the Federal Government concerned in standards work. These included the War Department, the Navy Department, the Department of Commerce, the Department of the Interior, and other departments and agencies. Then, about two years ago, a question was raised within the Federal Government regarding the legality of the Federal Government departments continuing to act as member bodies. When, in 1948, the Association was incorporated under the laws of the State of New York, the Federal Government departments withdrew from formal membership in the Association. It is hoped to restore the close coöperation within the Association between industry and Government which has heretofore existed by obtaining, through Congressional action, a Federal charter for the ASA with provisions specifically permitting membership by the Federal departments. A bill intended to bring this about has been introduced in the Congress by Senator Flanders of Vermont.

While a somewhat complicated organization is necessary to carry out its various responsibilities, the activities of the American Standards Association are run by two top bodies. The Board of Directors —which consists of the officers, 15 members designated by selected member bodies, and three members at large—has responsibility for the financial and administrative functions of the Association. The Standards Council, upon which all member bodies are represented, has the responsibility for all activities of the Association in the stimulation and approval of standards.

At the present time, there are more than three hundred standards projects being carried out under ASA procedures; and there is in addition a large volume of standards work under way by coöperating organizations which will later come to the ASA for consideration and approval. Standards are being approved or reaffirmed by ASA at the rate of two hundred a year.

Standards for drawings and drafting-room practice are among the ASA projects in which the Bell System is interested

As the work for which the Standards Council is responsible is very voluminous and diverse, it is to a large extent delegated to a series of divisions working in various fields: for example, electrical, mechanical, safety codes, etc. All of the work is, however, under the ultimate control of the Standards Council.

The ASA Staff

TO CARRY OUT its functions in connection with this volume of standards work, the Association has a very busy staff of about sixty people. Of these, half are technical or supervisory people.

The Association is fortunate to have at the head of the staff Vice Admiral G. F. Hussey, Jr., U. S. N. (retired). During the war, Admiral Hussey was in charge of the Bureau of Ordnance of the United States Navy, and he has brought to the ASA work his wide experience in business affairs and an extensive knowledge of American industry.

The staff of ASA does not have the responsibility for formulating standards. This is carried on by the volunteer activities of representatives of industrial and other organizations appointed to membership on the Sectional and other committees charged

with the development of standards. However, the staff of ASA gives very important assistance to these committees.

In some instances, members of the staff act as secretaries of the Sectional Committees. In any case, they form a valuable adjunct to the work of the committee through their knowledge of the standards work going on in this country and in other countries and of organizations and individuals who are able to contribute to the work of various projects.

A great deal of work is done by the staff in developing facts in connection with suggestions for additional standards projects, in meeting requests for information regarding standards in various fields, and in the whole range of activities for advancing the cause of standardization in this country.

ASA and the Bell System

BELL SYSTEM PARTICIPATION in this work has largely been carried out by the groups in New York. The American Telephone and Telegraph Company and the Western Electric Company have for years made payments to the Association on behalf of the Bell System companies as a group. These payments cover both company membership and the Bell System share of Member-body membership by the Telephone Group.

Depending upon the nature of the work involved in each case, Bell System representation in the Sectional Committees and other committees formulating standards is by members of the staff of the Western Electric Company, the Bell Telephone Laboratories, or the General Department of the American Telephone and Telegraph Company. Thanks to the Bell System form of organization, all of the Bell System Companies are thus represented in this work by a minimum number of representatives, and by men particularly qualified by their experience and responsibilities to contribute to the subject matter involved in each case.

THE AMERICAN STANDARDS ASSOCIATION has many problems.

Currently it is not able to supply the close liaison between industry and government in standards work which has characterized its operations in the past.

Like many organizations, it has budget trouble. The demands upon its staff for assistance in standards work outstrip its financial support, and result in a continuing problem of holding the work load down to what can be paid for. Looking ahead, it appears that there will be a continued expansion of the field in which its services will be desired.

However, the Association is well organized to meet its responsibilities and to expand its activities as increasing financial support makes this possible. It has established its place as an important tool in the rapidly developing American economy. The Bell System, which from the start has participated actively in its work and its support, can expect a continuance of the benefits which have come from the stimulation and coördination by ASA of standards in many fields which have nation-wide acceptance.

Carrier Systems, Which Transport Many Messages at One Time Over a Single Pair of Conductors, Are Now Used in Providing the Majority of Long Distance Circuits

Carrier Is King

Charles M. Mapes

WE ARE LIVING TODAY in a world which is more and more dependent on things electrical for carrying on its business and for making more pleasant its leisure hours. It is a world becoming increasingly complicated for those who must provide and maintain the many new electrical services—but much more satisfying for those who get the benefits.

It should be of considerable satisfaction to members of the telephone fraternity to reflect occasionally on the important part we have played in this advance toward better living, because, after all, communication is an important part of our way of life. Electrical communication not only provides means by which people, as individuals, can talk with one another, but it also includes the dissemination of entertainment, information, and even education to people *en masse*.

For example, a wide range of techniques and methods started from work on communications systems: radio broadcasting, hearing aids, telephotography, television, public address systems, and many others which contribute so much to the enjoyment of life today. Much of the "electronic" gear which plays such an important part in industrial, military, and other operations also got its start there.

There is one single factor which above all others may be said to dominate modern long distance communication by electrical means. This factor is "carrier." It is a key principle in achieving both the striking technical advances in long distance communication of the past quarter century and the savings to the customer which have come with them.

The carrier system is the communication industry's way of transporting many long distance messages simultaneously over a single pair of conductors—of making several blades of grass grow where but one grew before.

Because carrier makes it possible, for example, to superpose many communication channels upon one pair of conductors, the cost of the physical pair may be divided, so to speak,

Carrier Is Like Transportation

COMMUNICATION and transportation systems, although physically quite different, are basically similar enough to make possible an explanation by analogy.

Both carriers are concerned in transporting "packages" from one place to another. Transportation carriers handle a wide variety of sizes and kinds of physical packages. Communication carriers handle "packages" of frequencies,* and the "size" of the package is measured by the total width of the frequency band required.

One kind of communication package, for example, is speech. In both the sound and electrical worlds a band of frequencies several thousand cycles wide is needed to carry a message from a talker to a listener. The communication carrier is given this package by a telephone user and must transport it to a listener in such a way that the contents remain in good shape.

A telegraph message involves a smaller package—a band about 100 cycles wide. At the other extreme, the television program package is in the order of three or four million cycles. The illustration opposite indicates the relative sizes of packages for telegraph, telephone, radio program, and television.

Now let's take a look at the vehicles employed for carrying the packages. In the transportation business, the vehicles may range from the postman with his pack to trucks, trains, ships, and airplanes. In the communication field, the vehicles are quite different: bands of frequencies must be carried on special vehicles called "carrier" waves or channels.

As the diagram shows, a telegraph package is comparatively small, while a television program is a big package, one that tests the communication carrier's ability just as carrying a 100-ton casting tests the transportation carrier's ability.

Now the vehicles—or carrier waves—must have some place to run. A truck runs on roads, a train on tracks, an airplane through the air. In the communication industry the track or roads are the pairs of wires or the coaxial cable; and just as the airplane uses free space, so, in the communication industry, does radio.

In the communication field, the width of the track can be thought of as the total width of the frequency band which is put over the pair of wires or the coaxial unit or free space—and this width can be varied as required to accommodate the size of the load. This is a very important advantage over the fixed gauge of a railroad or the width of a highway, since it makes it possible for one conducting medium to handle a great variety of sizes of vehicles and packages. Basically, the usual carrier process is to separate the whole usable frequency band of the conducting medium into individual blocks of frequencies, the size of the blocks depending on the width of the band required for each type of package.

The use to which frequency space has been put up to this time in the Bell System can be visualized from the diagrams on pages 198 and 199.

* A variation of current from a negative value to a positive value and back again is known as a cycle. If such a cycle occurs in 1/100 of a second, for example, then 100 cycles may be transmitted in one second, and the varying current is said to have a frequency of 100 cycles per second. Transmission of the various kinds of intelligence such as telegraph signals, speech, or television makes it necessary to have currents which complete this cycle a few times a second for communications of a simple character up to millions of times per second for the more complex requirements.

among all the circuits it carries—although there is, of course, some extra expense for added equipment.

Carrier can provide more circuits quickly, where conductors already exist; for then it may not be necessary to run new wire or provide another cable, but just to provide the right equipment at each end and at points along the line. This was a life-saver in meeting the sudden load on the nation's toll system during the last war, and the more so because copper and lead were among the crucially scarce items.

Carrier is fundamental to both radio broadcasting and television broadcasting.

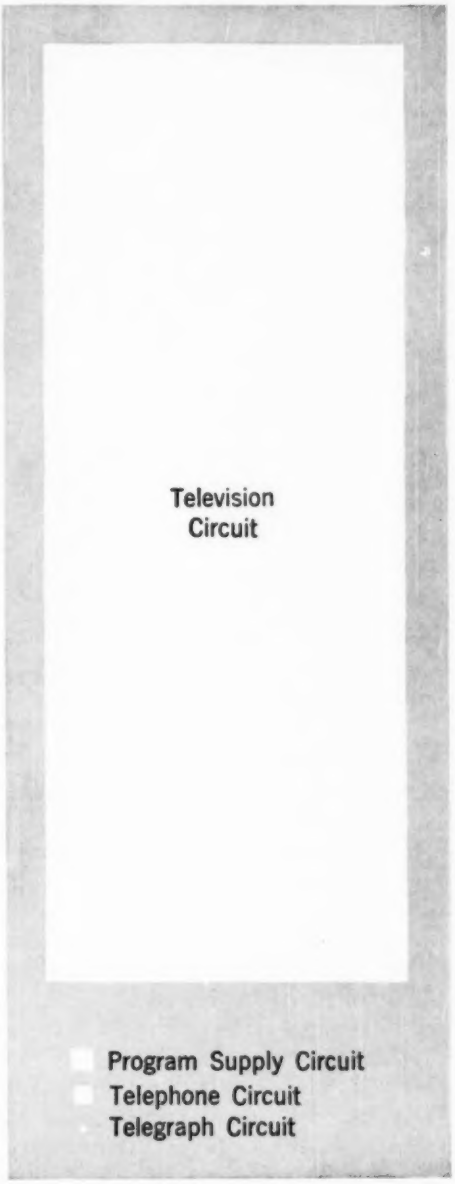
Carrier forms the backbone of the Bell System's intercity networks. It provides about 60 percent of the intercity telephone circuit mileage, about 75 percent of the intercity telegraph circuit mileage, about 35 percent of the intercity radio program network mileage, and all of the intercity television program mileage—both coaxial and radio.

Indeed, carrier is, in a sense, king of long distance communication methods.

An Important Factor

OBVIOUSLY, a technique which handles so much of the Bell System's present business is an important factor in its operations.

It is an interesting thought, if somewhat incidental to our principal theme here, that Alexander Graham Bell's invention of the telephone came about as a conseqence of his efforts to send several telegraph messages over a single wire. He never did bring his "harmonic" telegraph system to commercial operation—which is probably



This illustrates the relative sizes of the "packages" which must be handled by communication carrier. The areas of the rectangles are proportional to the frequency bands required

Lee deForest. From his audion was developed the whole family of vacuum tubes, including the modulators and demodulators essential for carrier transmission

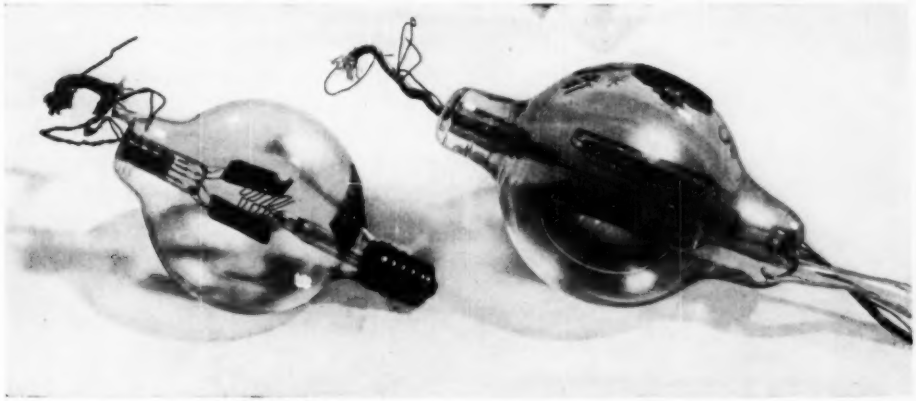
just as well, for he might then have had less interest in the telephone. But the attempt to send more than one telegraph message over a single conductor was accomplished by others, of course, and this event may be considered as a point of departure for the growth of "carrier." Yet only within comparatively recent years has carrier really come into its own.

The job of a communication system —to begin at the beginning—is to transport (although we generally say "transmit") messages electrically, be they the start-stop signals of the teletypewriter, the articulation of the voice, or the light and dark values of a telephotograph or a television program. This is done by making changes in an electric current or wave to correspond with the message, transporting the changed current to its destination, and there translating the current back into the original message.

It is a fact—by way of example—that no one has ever heard the human voice over the telephone, but only a reproduction of it; for the transmitter transforms the words into an electric current which varies as the sound waves of the voice vary, and the receiver at the far end re-transforms the current into the sound waves which become replicas of the words originally spoken.

Each message, then, of whichever kind, constitutes a set of changes in an electrical current. And the function of a modern carrier system is to transport—to carry, in fact—several or many of these sets of changes over a single path, be it a pair of conductors or a radio beam.

The way a carrier system of the type commonly used does this is to take the band of frequencies representing each message and move it up in the frequency scale to an appropriate position. Each band of frequencies representing a message may be said to be at the bottom of the scale, and each must be moved up to a different position in this scale, else they will become mixed up. These bands are all then transported over the common medium to the destination.



Development exemplified: deForest's audion (left) as submitted to the laboratories of the Western Electric Company (later a component of the Bell Telephone Laboratories) in 1912, and the high-vacuum tube developed there in 1913 for the first successful telephone repeater

At this point the individual bands must be sorted out and separately translated down again in the frequency scale to their original positions.

Thus, one of the elements of a carrier system is a method of moving a band of frequencies from its original position to the proper position in the carrier frequency region for transportation over the medium. This is accomplished in a device known as a "modulator." The medium—physical conductors or radio beam—must be adequately conditioned for transmitting all of these separate sets of frequencies which have been created. At the receiving end these sets must be separated and conducted to individual devices called "demodulators" which translate them back to their original frequencies.

Solving Practical Problems

WHILE THESE PRINCIPLES had long been known, there were in the early years unsolved practical problems involved in their application. Then, in the early 1900s, two powerful new tools came into being.

One was the "audion" of Dr. Lee deForest, which was the forerunner of the now large family of vacuum tubes. This audion of Dr. deForest, after further refinement at the Bell Telephone Laboratories, could be used as an oscillator, an amplifier, a modulator, and a demodulator. (Together with Edison and a few others, deForest can properly be charged with the fact that today we are importuned on every hand to buy something or other because it is "electronic.")

The second tool was the "electric wave filter" of Dr. G. A. Campbell. As a mathematical physicist and inventor, George Campbell spent 38 years of distinguished service in the Bell System, retiring in 1935 from the staff of the Bell Telephone Laboratories. His electric wave filter was an ingenious arrangement of elements by which particular bands of frequencies coud be separated from other bands,

and thus it could be used to separate the various channels making up a carrier system.

With the vacuum tube and the electric wave filter, the essential elements of the carrier system were at hand. However, there were still at least two serious difficulties.

The vacuum tube and the wave filter made the equipment in the carrier terminals practical, but they did not necessarily make it cheap. Of course, if the terminals of the circuits are far enough apart, and enough additional circuits can be obtained, the cost of the carrier terminal equipment does not affect the over-all circuit cost very much, because of the much greater saving in outside plant investment. But if the terminals are close together, their cost may offset the savings in conductor cost. Thus, the earlier carrier systems were used only over fairly long distances, and even today the tendency is to think of carrier as a relatively long-haul system.

The second difficulty is that the losses—or diminution of strength—of the currents transmitted over conductors go up as the frequency used is increased. Even in the voice range, it has been found necessary to use amplifiers—or "repeaters"—at intervals along the line in order to prevent the strength of the currents from reaching unusably low levels. With the higher frequencies involved in carrier systems, these repeaters must be closer together and in general must be fairly complex. Thus, the cost of these added repeaters tends further to offset the reduction in conductor costs resulting from the multiple use of the physical circuit.

However, the obstacles of the terminal and repeater costs, and others, such as cross-talk, had been sufficiently well overcome by 1918 to permit commercial operation of the first carrier system on an open wire pair. Since then, developments have been rapid—until now, carrier is an essential part of the telephone business as well as the key of the radio world.

Open-Wire Carrier Systems

IT WAS NATURAL that carrier should originally be applied to open wire. In the first place, there wasn't much in the way of an intercity cable network in 1918. In the second place, the number of conductors which can be put on an open-wire pole line is limited, so that increasing the capacity of the pole line by carrier is particularly important. Last, but not least, attenuation and other problems were easier to overcome in open wire than in the types of cable then in use. There are now four principal types of carrier systems in wide use on open-wire lines in the Bell System: the systems known alphabetically as C, H, J, and M. (The earliest systems were the Types A and B, which are no longer in use.)

The C system is one of the most widely used open wire carrier telephone systems in the world. It provides three channels on a single pair of wires, and the present-day terminals are cheap enough so that the system can be used for relatively short distances—in many cases as low as 50 miles or so. On the other hand, its characteristics are such that operation is practicable for circuits several thousand miles long and, in fact, it is used for such distances.

The H system is basically designed for the shorter lengths. It provides one channel per pair of wires (in ad-

dition to the voice channel on the pair) and is economical in many cases down to distances as short as 25 to 30 miles.

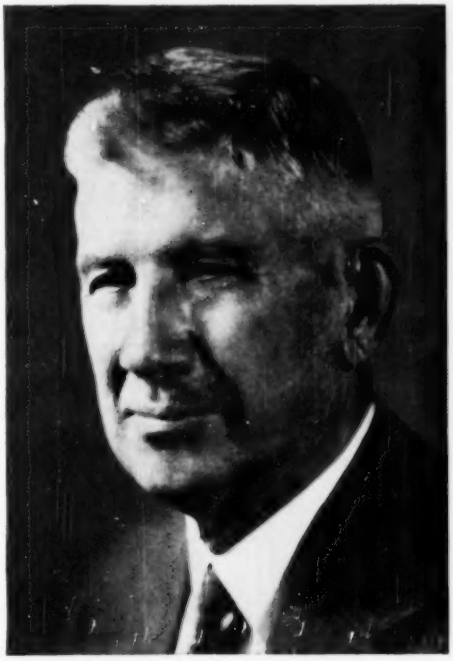
The J system provides 12 circuits on a single pair(in addition to the voice and a C or H system) but the equipment is more expensive. This is because it is designed to meet such rigid requirements that it will operate satisfactorily over transcontinental distances, and also because of the need for special devices to combat the effect of sleet on wire lines. Hence it is seldom used for distances less than 100 to 150 miles. By using J and C systems on the same pair, a total of 16 circuits (including the voice frequency circuit) can be carried.

The M system was designed originally to be superposed on power lines in order to provide rural telephone service. However, it has been adapted for application to open-wire pairs for short-haul circuits, and when so used it can provide up to five additional telephone circuits on a line. It uses higher frequencies than the other systems, and hence cannot be used so widely.

In addition, several of the earlier types of systems are still in use—notably the single-channel D and G systems.

The Type K Cable Carrier System

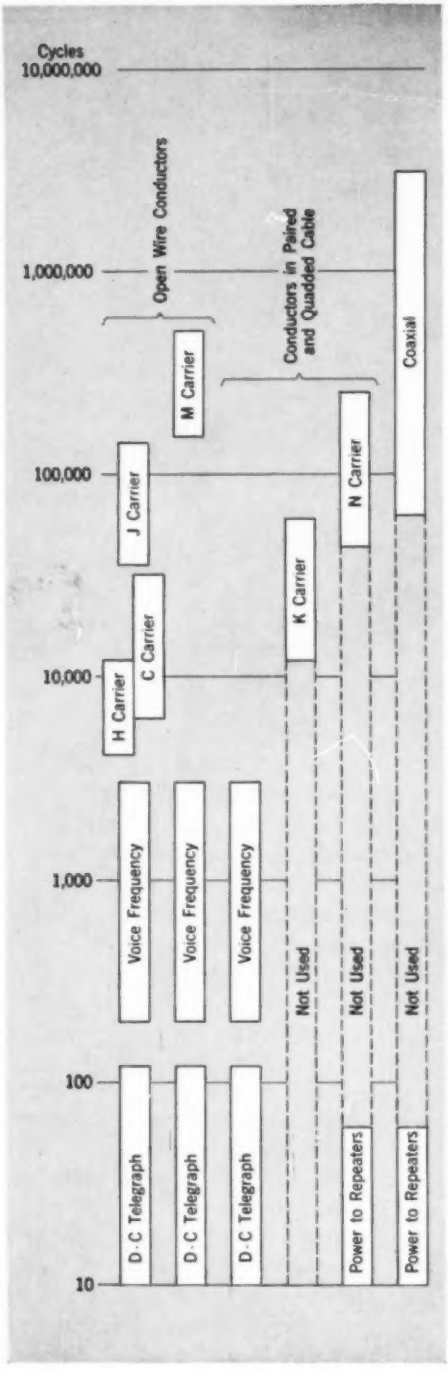
THE PROBLEMS INVOLVED in operating carrier systems in cables of the usual type are more difficult than those concerned with open wire, because cables use small conductors which are very close together. Thus, attenuation and the tendency to crosstalk between different circuits are both greater than for open wire, particularly at the higher carrier frequencies.



George A. Campbell. His electric wave filter provided one necessary tool for carrier development. This picture was made before his retirement from the Bell Telephone Laboratories in 1935

Because of these problems and the lesser need for cable carrier in the early years, it was not until 1938 that the first telephone cable carrier system—a 12-channel system known as Type K—was placed in operation between Detroit and South Bend. Since then, however, the use of K systems has increased enormously.

The K system is designed to be usable up to about 4,000 miles—more than the longest circuit in the country. In circuits of such length, the problems of transmitting a wide band of frequencies become very difficult, and the K system is designed, therefore,



to use the narrowest possible band practicable for a high quality telephone circuit. This of course requires very effective "frequency-slicing" instrumentalities. It puts a circuit over 3,000 cycles wide in a "slice" or channel only 4,000 cycles wide, and stacks 12 such channels in the frequency space between 12,000 and 60,000 cycles. The slicing equipment is, of course, very highly refined, and the same frequencies are used for both directions of transmission. People like to talk to each other, so every telephone circuit must be like a double track railroad, and in the K system the two directions of transmission are put on two separate pairs, usually in two separate cables.

Thus, for example, on a New York-Chicago connection over a K system, when the New Yorker is talking, he uses a path on a pair in one cable; and when the Chicagoan responds, he uses a path on another pair in another cable.

Even using this method, the attenuations which are encountered reach very high figures. For example, on a transcontinental call over a K system, there are about 200 repeaters, spaced about 17 miles apart. The power amplification in all of the repeaters—which is, of course, about equal to the total attenuation—is equal to digit *one* followed by a thou-

Left: The frequency bands used in the Bell System's wire communication system. This chart and the one opposite are on a logarithmic scale: equal intervals vertically mean equal ratios of frequency and not equal width of bands. To obtain the band width in cycles, one must subtract the bottom frequency of any given band from the top frequency

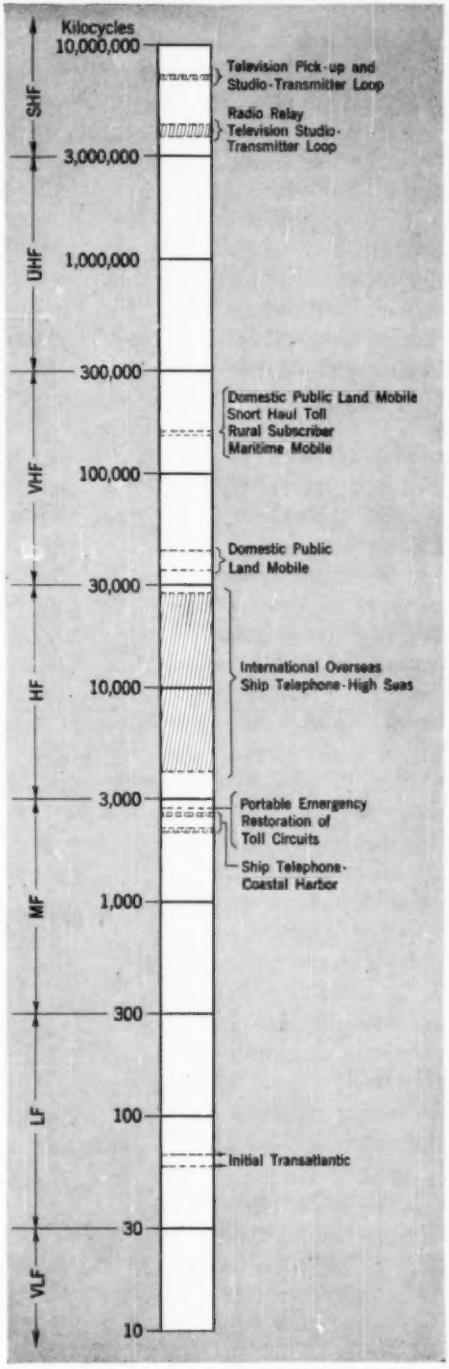
sand zeros: a figure so enormous that it is practically inconceivable.

The Coaxial System

OF ALL of the carrier systems developed to date, the coaxial has been most in the public eye. Part at least of the glamour attached to the coaxial system is that it is the only one of the wire transmission systems which will carry television programs over long distances at the present time.

While that is an important function, actually the coaxial cable and the associated carrier systems are work horses in the telephone business, just as are the other carrier systems, and their principal purpose is to carry large numbers of telephone circuits over long distances.

The coaxial system carries the principle of lowering conductor costs by multiple use of the physical circuit further than any of the other carrier systems. Two copper tubes, each about three-eighths of an inch in diameter and with a 1/10-inch wire down the center of each, are made to carry up to 600 telephone circuits, and four such pairs of tubes can be put in a single cable. In general, it is not planned to use more than three pairs of tubes for regular service, while keeping one pair as a "standby," so that the practical maximum number of circuits in the cable is 1800 rather



Right: Radio frequency bands used by the Bell System. The logarithmic scale is essential here for practical reasons; for if an ordinary linear scale were used, and were so arranged that only 1/10 of an inch were allotted for the d-c telegraph scale on the opposite page, that chart would be more than 30 feet long, and this one many thousands of feet long

than 2400. Also, if any of the tubes are used for television, the capacity of the cable for telephone circuits is reduced correspondingly.

Below appears a cross-section of a typical cable containing eight coaxials and a number of other pairs, some of which are used in connection with the operation of the carrier system and the others of which may be used for other telephone circuits. The two directions of transmission are usually in adjacent tubes in such a cable, these two tubes performing the same function of separating directions as do the two cables used with the K system.

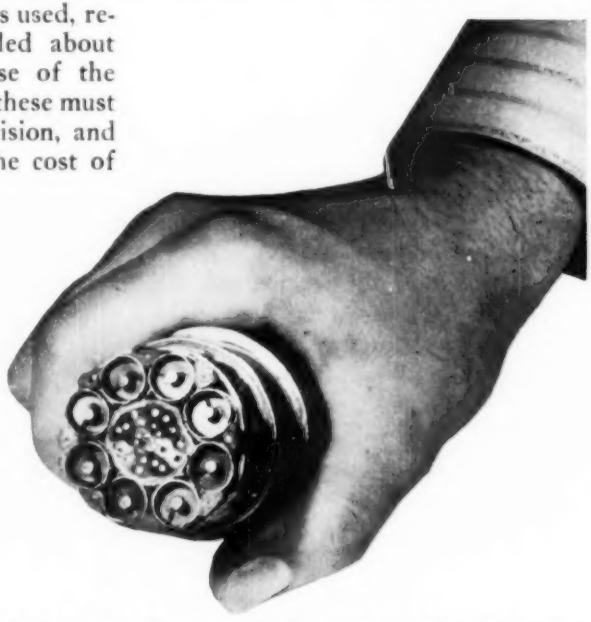
The terminal equipment used with coaxial cables is relatively expensive, so that very few such systems are used for distances under about 100 miles or on routes where the required number of circuits is not large. Also, because of the high frequencies used, repeaters have to be installed about every eight miles. Because of the wide frequency bands used, these must be designed with high precision, and their cost, together with the cost of the cable and terminal equipment, makes the coaxial system economical only for large circuit concentrations.

It should perhaps be pointed out that the limitation in the number of telephone circuits or the frequency width of a television circuit which can be put on the coaxial tubes is primarily a function of the terminal and repeater equipment, rather than of the tubes themselves. As new requirements may develop, it is to be expected that new methods can be devised to meet them.

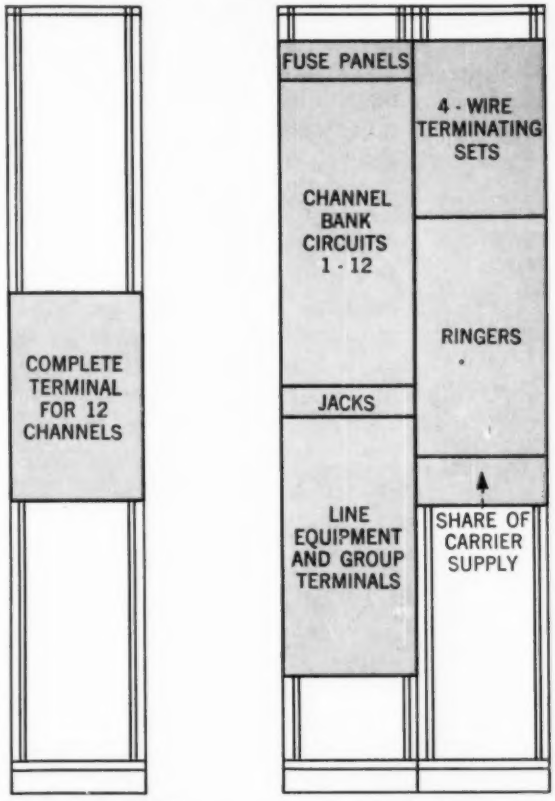
N1—A New Short Haul Cable Carrier

THE SHORT-HAUL TOLL FIELD differs in two important respects from the long haul field. While the first and obvious difference is the fact that the circuits are shorter, there is an equally important difference in that these shorter circuits should be able to reach towns, villages, and hamlets along the way—sort of an "area coverage" problem. There is usually little opportunity to concentrate circuits into large bundles, as can often be done on the main long-haul routes.

What are needed, then, in a short-haul system are, first, cheap terminals, so that they can be put close to-



End-on view of an eight-tube coaxial cable. Each pair of coaxial tubes can transmit as many as 600 telephone conversations, and a feature of the cable is its ability to handle television



This sketch contrasts the size of the new 12-channel N1 terminal now under development (left) with the 12-channel K terminal

gether; and second, arrangements so that many small circuit groups can be handled economically. These are both tough problems.

However, new materials and techniques have been developed within the past few years; and these, together with two other essential ingredients—imagination and "know how"—are promising carrier systems which will divide conductor costs among fairly large numbers of circuits without requiring expensive terminals and without impairing the flexibility needed for area coverage. The N1, now under development, is such a system.

Since the N1 system is designed specifically for the shorter circuits—up to about 200 miles in cable—and because certain new techniques are used, it does not run into as much trouble in using a wide band of frequencies on the line as would a long-haul system. It uses an 8,000-cycle slice of frequency for about a 3,000-cycle circuit, and uses a total frequency band 96,000 cycles wide for one direction of transmission for 12 circuits and another 96,000 for the other direction. By this process, the equipment at the terminals can be made much simpler and cheaper than for K or coaxial. It uses a different cable pair for each direction of transmission, but by using different frequencies for the two different directions, and other special measures, both pairs can be put in the same cable.

The N1 terminals and repeaters are marvels of compactness. For example, the sketch above shows a comparison between the size of a 12-channel K terminal and a 12-channel N1 terminal. All of the equipment in the

N1 system is so arranged that in case of trouble a defective unit can be easily and quickly replaced by a good one, and the defective one may be repaired without emergency pressure.

Radio

IN THE RADIO art, carrier waves are used to get the program to your set, be it A.M. or F.M.; and the same is true of television. Without carrier waves and the ability to filter out the signals of one particular program from all others, the wide variety of entertainment we today enjoy from commercial broadcasts would not be possible.

Every time you turn on your radio and twist a knob or push a button in search of a particular program, you are selecting the carrier wave sent out by that particular station to bring you its package of entertainment. It is good that carrier waves can travel through space, for the problem of getting the large number of radio and television programs to your home by wire circuits would be a bit difficult.

For the telephone business, radio opens up a whole new field of investigation and trial which may substantially affect the future technique of providing additional telephone circuits.

Radio obviously uses a different approach to the problem of reducing conductor costs from that of the wire carrier system. Instead of trying to get a wider band of frequencies over a pair of conductors, it cuts the Gordian knot by eliminating the conductors entirely and, like the airplane, takes off into free space. Like the airplane, it must pay some penalties for its boldness: the mechanisms are complex and it must face new and difficult problems in transmission.

The telephone industry has already made history by using radio first in those cases where its particular features are most attractive. Reference to the diagram on page 199 will indicate the several bands of frequencies which are already devoted to radio as a work horse in the communication business. These include, for example, transmission over large bodies of water, overseas, from mainland to islands, etc.; transmission over very rugged terrain; and transmission to moving automobiles, vessels, and airplanes, where obviously wire methods would be impossible.

More recently, micro-wave radio relay systems are giving promise of supplementing wire systems for ordinary communication purposes in situations where wire systems have always been thought to be preëminent. Extensive micro-wave radio systems are now under construction or planned and it appears that they will take an important place in the overall communication network and play their part in transporting all of the types of packages that the communication industry is called upon to carry.

The full extent to which radio will be used in the communication field is still to be determined. But all branches of the industry are alert to its possibilities, and we may be sure that as the Bell System goes forward, there will be an increasing use of this new technique.

Conclusion

IN PRINCIPLE, carrier systems of the usual type are simple. All one does is mix each message with a carrier frequency, pile up the resulting mix-

INTERCITY CIRCUIT MILES IN BELL SYSTEM
(Millions of Miles)

	Voice Frequency	Carrier				Total	Percent in Carrier
		Open Wire	K	L	Total		
1926	3	.1	—	—	.1	3.1	3
1938	7.3	1	—	—	1	8.3	12
1941	7.5	1.2	.6	—	1.8	9.3	19
1945	7.8	2.2	4.2	—	6.4	14.2	45
1948	8.3	2.8	6.7	2.7	12.2	20.5	61

This table shows the growth of carrier circuits in the Bell System in less than a quarter of a century

tures within the frequency space to be used, transport them to the destination, separate them, and unmix them.

It isn't actually quite so easy as that, of course. The practical application of carrier calls for special materials, delicate devices, skilled techniques. Their use is inherent in the kinds of carrier which have been described here, and they are part of the working tools of the business. Carrier, as has been made evident, is throughout the Bell System a thoroughly practical, every-day matter.

Its development is by no means at an end, however. Theoretically, there is no limit to the width of the "track" (i.e., the frequency band) which can be put on a pair of wires, on a coaxial unit, or in free space. But one of the laws of nature seems to be that the wider the frequency band to be used, the greater are the difficulties involved in using it. There is, in consequence, a constant search for ways to get more channels in a given frequency band, or to lessen the costs of dividing the band into the individual slices necessary for the channels, and likewise to find better and cheaper ways of widening the usable frequency band.

Carrier has developed from the early Type A to today's advanced systems in about 30 years: less than one generation. Many factors have contributed, over the years, to that development, that progress. Important among them have been such intangibles as imagination and teamwork and know-how and an ability to recognize the value of an idea from whatever source. It is these same qualities which bespeak the continued development of the carrier art, with better telephone service in their train.

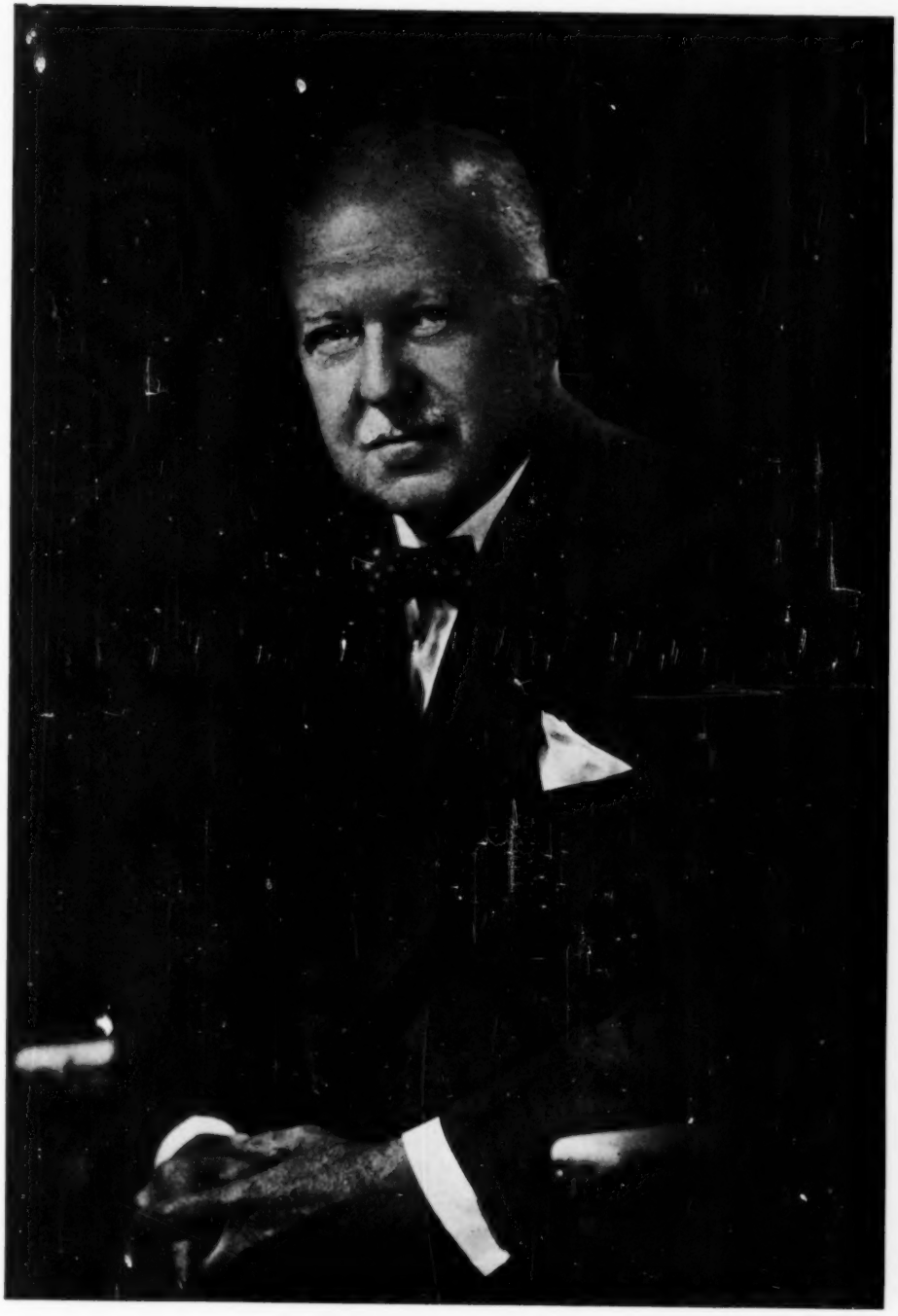
Mr. Gifford Retires

After more than forty-five years of service in the Bell System, during twenty-three years of which he served as President of this Company, Walter S. Gifford, Chairman of the Board, retired on December 31, 1949, in accordance with the Company's retirement plan.

At their meeting on December 21, the Directors paid tribute to the courage, wisdom, and foresight with which Mr. Gifford led the Bell System through nearly a quarter-century of outstanding achievement. They noted that during his presidency, fundamental policies were formulated and put into practice that have made the Bell System an institution the American people can be proud of. And they expressed their appreciation of his long and distinguished contribution to the welfare of the Company and the public, their personal affection for him, and their best wishes for the future.

The Directors designated Mr. Gifford as their Honorary Chairman, and as such he will continue to be available for advice.

Walter Sherman Gifford entered the Bell System in 1904 as a clerk with the Western Electric Company in Chicago. In 1906 he became assistant secretary and assistant treasurer of Western Electric in New York. In 1908 he joined the A. T. & T. Co., and was chief statistician from 1911 to 1916. He was appointed comptroller in 1918. The following year he was elected vice president, and executive vice president in 1923. He was elected President of the Company in 1925, and Chairman of the Board of Directors in February of 1948.



WALTER S. GIFFORD

The A. T. & T. Company's Annual "Telephone Statistics Of the World" Summarizes Much Information about the Telephones in Service on All Continents

This Country Leads the World in Telephones

Elizabeth Wrenshall

OF THE WORLD'S 65,800,000 telephones, there is, on the average, one for every four people in the United States, one for every thirty-five people in the world as a whole: twenty-one times as many telephones per 100 of the population in this country as in the world outside the United States.

These facts, and many others having to do with the distribution of the world's telephones as of January 1, 1949, are set forth in the current issue of "Telephone Statistics of the World," published recently by the Chief Statistician's Division of the American Telephone and Telegraph Company. Similar compilations have been published annually, except for the war years, since 1912. The accurate picture of world telephone facilities presented in the current survey is made possible through the cooperation of government administrations and private companies which operate the many parts of the global telephone network.

On the average, a telephone user in the United States, whether in a large community or a small one, is able to reach a greater proportion of his fellow-countrymen by telephone than is a citizen of any other country. He has available to him the most rapid system of intercommunication in the world today. It is possible for him to be connected with more than nine-tenths of the world's telephones. He is able, on the whole, to make toll calls more rapidly, and at relatively lower rates, than is the telephone user of any other country. In continental Europe, where toll service is notably slow, provisions have been made for a faster service on a so-called "urgent" and a "lightning" basis at from two to twenty times the rates of ordinary toll calls. The Bell System's normal toll business is a

(*Continued on page 210*)

TELEPHONES IN CONTINENTAL AREAS
January 1, 1949 [a]

Continental Area	Total Telephones			Privately Owned		Automatic (Dial)		Connecting with Bell System	
	Number	Per Cent of Total World	Per 100 Population	Number	Per Cent of Total Tels.	Number	Per Cent of Total Tels.	Number	Per Cent of Total Tels.
North America (less United States)	2,959,000	4.5	4.6	2,613,000	88.3	1,701,000	57.5	2,950,000	99.7
United States	38,205,000	58.1	26.1	38,205,000	100.0	23,830,000	62.4	38,193,000	100.0 [b]
South America	1,574,000	2.4	1.5	810,000	51.5	1,133,000	72.0	1,457,000	92.6
Europe	18,940,000	28.8	3.2	2,670,000	14.1	11,960,000	63.1	17,580,000	92.8
Asia	1,923,000	2.9	0.2	150,000	7.8	820,000	42.6	700,000	36.4
Africa	735,000	1.1	0.4	9,000	1.2	475,000	64.6	595,000	81.0
Oceania	1,464,000	2.2	1.4	106,000	7.2	885,000	60.5	1,425,000	97.3
World	65,800,000	100.0	2.8	44,563,000	67.7	40,804,000	62.0	62,900,000	95.6

[a] Partly estimated; data reported as of other dates have been adjusted to January 1, 1949.
[b] Less than 0.05 per cent do not connect.

Part of the overseas operating room in New York, showing the murals of foreign scenes above the switchboard. Here are handled calls with Europe, South America, the Near East, and with ships at sea. Similar switchboards in Florida and California handle calls with other lands, and with ships as well, and thus the United States not only has almost three-fifths of the world's telephones but is able through its overseas services to connect with all but about five percent of the rest

TELEPHONES IN COUNTRIES OF THE WORLD

January 1, 1949

Country	Total Telephones			Ownership		Automatic (Dial)		Connecting with Bell System	
	Number	Per Cent of Total World	Per 100 Population	Government	Private	Number	Per Cent of Total Telephones	Number	Per Cent of Total Telephones
NORTH AMERICA:									
United States	38,205,483	58.1	26.1	—	38,205,483	23,830,000	62.4	38,193,281	100.0 [a]
Alaska	12,614	†	13.3	36	12,578	815	6.5	12,614	100.0
Canada	2,458,000	3.7	18.8	308,700	2,149,300	1,384,000	56.3	2,458,000	100.0
Central America [b]	40,900	†	0.4	17,000	23,900	11,400	27.9	36,200	88.5
Cuba	100,700	0.2	1.9	503	100,197	83,246	82.7	100,700	100.0
Jamaica	10,275	†	0.8	—	10,275	9,527	92.7	10,275	100.0
Mexico	248,000	0.4	1.0	835	247,165	169,630	68.4	248,000	100.0
Puerto Rico	34,763	†	1.6	1,794	32,969	17,467	50.2	34,763	100.0
Trinidad & Tobago	12,216	†	2.0	—	12,216	7,503	61.4	12,216	100.0
Other Places [b]	42,100	†	0.6	17,400	24,700	17,850	42.4	36,950	87.8
SOUTH AMERICA:									
Argentina	679,335	1.0	4.1	599,262	80,073	500,872	73.7	645,000	94.9
Bolivia	7,860	†	0.2	—	7,860	7,415	94.3	6,950	88.4
Brazil	484,300	0.7	1.0	1,500	482,800	360,000	74.3	435,000	89.8
Chile	126,033	0.2	2.2	—	126,033	83,693	66.4	126,033	100.0
Colombia	70,300	0.1	0.6	61,800	8,500	29,950	42.6	50,000	71.1
Ecuador	18,882	†	0.5	13,927	4,955	4,900	26.0	4,500	23.8
Paraguay	4,986	†	0.4	4,986	—	4,346	87.2	4,298	86.2
Peru	44,400	†	0.6	—	44,400	35,085	79.0	38,152	85.9
Uruguay	77,686	0.1	3.3	76,146	1,540	55,879	71.9	77,686	100.0
Venezuela	55,272	†	1.2	1,258	54,014	50,755	91.8	55,272	100.0
Other Places [b]	5,007	†	0.8	5,007	—	171	3.4	4,400	87.9
EUROPE:									
Austria	350,592	0.5	5.0	350,592	—	285,335	81.4	350,592	100.0
Belgium	601,614	0.9	7.0	601,614	—	443,638	73.7	601,614	100.0
Bulgaria [c]	54,347	†	0.8	54,347	—	23,000	42.3	0	0
Czechoslovakia [c]	350,708	0.5	2.9	350,708	—	208,319	59.4	350,708	100.0
Denmark	644,975	1.0	15.3	[d] 32,196	612,779	259,958	40.3	644,975	100.0
Finland	302,104	0.5	7.3	34,604	267,500	158,483	52.5	302,104	100.0
France	2,232,536	3.4	5.5	2,232,536	—	1,336,790	59.9	2,232,536	100.0
Germany—American Zone	630,756	1.0	3.8	630,756	—	283,955	45.0	630,756	100.0
Germany—British Zone	1,160,924	1.8	5.1	1,160,924	—	597,146	51.4	1,160,924	100.0
Germany—French Zone	182,356	0.3	3.4	182,356	—	80,000	43.9	182,356	100.0

Greece	65,078	†	0.8	3,516	61,562	[e] 57,217	87.9	65,078	100.0
Hungary [c]	106,768	0.2	1.2	106,768	—	77,492	72.6	106,768	100.0
Iceland	17,632	†	12.8	17,632	—	10,715	60.8	17,632	100.0
Ireland	66,806	0.1	2.2	66,806	—	38,325	57.4	66,806	100.0
Italy	1,014,321	1.5	2.2	—	1,014,321	908,448	89.6	928,780	91.6
Luxemburg	20,287	†	7.0	20,287	—	14,567	71.8	20,287	100.0
Netherlands	632,667	1.0	6.4	632,667	—	557,839	88.2	632,667	100.0
Norway [f]	404,985	0.6	12.7	336,404	68,581	234,760	58.0	404,985	100.0
Poland	212,000	0.3	0.9	212,000	—	142,000	67.0	140,000	66.0
Portugal	124,305	0.2	1.5	36,178	88,127	61,259	49.3	123,128	99.1
Spain	552,467	0.8	2.0	—	552,467	401,800	72.7	552,467	100.0
Sweden	1,531,473	2.3	22.1	1,529,396	2,077	918,135	60.0	1,505,832	98.3
Switzerland	794,832	1.2	17.2	794,832	—	754,056	94.9	794,832	100.0
United Kingdom [d]	4,922,816	7.5	9.8	4,922,816	—	3,420,395	69.5	4,922,816	100.0
Other Places [b]	1,990,000	3.0	0.7	1,990,000	—	711,500	35.8	870,000	43.7
ASIA:									
China [c]	244,028	0.4	†	84,028	160,000	178,000	72.9	170,000	69.7
India [g]	126,412	0.2	†	124,900	1,512	53,000	41.9	112,652	89.1
Israel	20,701	†	2.4	20,701	—	18,400	88.9	20,447	98.8
Japan [d]	1,348,552	2.0	1.7	1,348,552	—	449,517	33.3	460,600	34.2
Pakistan	16,454	†	†	16,454	—	9,124	55.5	16,454	100.0
Turkey	52,423	†	0.3	52,423	—	46,010	87.8	0	0.0
Other Places [b]	147,000	0.2	0.1	92,000	55,000	81,000	55.1	0	0.0
AFRICA:									
Algeria	81,800	0.1	0.9	81,800	—	56,665	69.3	68,000	83.1
Egypt [c]	98,093	0.1	0.5	98,093	—	65,268	66.5	98,093	100.0
Morocco	49,034	†	0.5	40,234	8,800	31,250	63.7	43,529	88.8
Tunisia	22,026	†	0.6	22,026	—	13,005	59.0	15,000	68.1
Union of South Africa	384,633	0.6	3.2	384,633	—	267,961	69.7	331,000	86.1
Other Places [b]	97,000	0.1	†	96,745	255	38,100	39.3	34,000	35.1
OCEANIA:									
Australia	995,773	1.5	12.8	995,773	—	602,442	60.5	995,773	100.0
Hawaii	94,559	0.1	17.5	—	94,559	87,069	92.1	94,559	100.0
Netherlands Indies [h]	29,438	†	†	29,438	—	713	2.4	8,525	29.0
New Zealand [d]	322,757	0.5	17.2	322,757	—	186,300	57.7	321,117	99.5
Philippine Republic	11,534	†	†	—	11,534	8,771	76.0	9,103	78.9
Other Places [b]	20,700	†	†	20,700	—	3,100	15.0	600	2.9

† Less than 0.1.
[a] Less than 0.05 per cent do not connect.
[b] See page 9 for detail.
[c] January 1, 1948.
[d] March 31, 1949.
[e] Subscribers only.
[f] June 30, 1948.
[g] March 31, 1948.
[h] Territory under authority of Netherlands Indies Government.

"lightning" service. Ninety-five percent of all long distance connections are now completed while the person calling holds the line. This is a new record in the telephone industry.

Speed of long distance connections in the United States is being further increased by expansion of intercity operator toll dialing. Recently a long distance call from Oakland, Cal., made with this type of service, was answered in New York City—a distance of some 3,000 miles—in twelve seconds.

Bell Telephone service in the United States means continuous day and night service on weekdays, Sundays, and holidays, for small towns as well as for large cities. In many parts of the world this is not the case.

Service in rural areas has been growing fast. In the last few years it has been extended by swift, economical construction methods and important new techniques. As a result of this program, 1,300,000 rural telephones have been added since the close of World War II. The United States today has a higher percentage of farms with telephones than any other nation, and rural service here is better than anywhere else in the world.

British Field Marshal Viscount Montgomery of Alamein visited the Bell Telephone Laboratories this winter, and is here seen examining synthetic crystals such as are grown for use in telephone plant. It is the Laboratories' contributions to the science and technology of communication which help to keep Bell System service constantly improving and make it the envy of visitors from other countries

Telephones Considered by Countries

IN CONSIDERING the extent of telephone facilities by countries, the number of telephones in relation to the population served is a significant measure of comparative development.

Only six countries in the world had more than fifteen telephones per 100 population. They were the United States, with 26.1 telephones per 100 of its population; Sweden, with 22.1; Canada, with 18.8; New Zealand and Switzerland, with 17.2 each; and Denmark, with 15.3.

Argentina ranked first among South American countries in respect of telephone density—so called—with 4.1 telephones per 100 population. Sweden led in Europe with 22.1; Israel, in Asia, with 2.4. New Zealand, first in Oceania, had 17.2; and the Union of South Africa led Africa's countries with 3.2. The rest of the world would have to add some 540 million telephones in order to attain our relative telephone development. In this country there is an average of about 26 telephones per 100 persons, while in the world outside the United

States there is little more than one telephone to each 100 persons. If in the United States the number of telephones were reduced to the development-ratio obtaining in the world outside this country, there would be only 1,857,000 telephones serving our entire population. The net gain in telephones in the United States for the year 1949 alone exceeded this figure.

Those countries having the greatest population have relatively low telephone development. For example, China, with a larger population than any other country on earth, has an average of one telephone for each 1,840 persons. India, second in population, has one for each 2,650; the U. S. S. R., third in this respect, one for each 143 persons. These three countries, embracing, in the aggregate, almost one-half of the world's population, are served by only one thirty-fifth of the world's telephones. On the other hand, the United States, with but 6 percent of the world's population, has nearly 60 percent of the total number of telephones.

Visitors from India and Pakistan regard the New York scene from atop the Long Lines Department headquarters building. The contrast is striking, for those two countries together have fewer than 150,000 telephones—approximately one for each three thousand inhabitants—while the city which surrounds these young people has nearly 35 telephones for each 100 inhabitants

Ownership

THE WORLD'S largest telephone system, that of the United States, is operated under private ownership and has been so operated since its inception. In October 1949 the telephone industry in this country passed the 40 million mark in number of telephones in service. Of these, more than four-fifths were operated by the Bell System.

The world's second largest telephone system in point of number of telephones in service, that of the United Kingdom, is, at the same time, the largest system under government ownership. With the exception of three municipally owned systems, which are located in Hull and in the channel islands of Guernsey and Jersey, the British system is operated as a branch of the General Post Office.

The five countries having the greatest number of telephones operated under private ownership rank as follows in respect to total number of telephones: United States, Canada, Italy, Denmark, and Spain.

The five countries reporting the greatest number of their telephones

(*Continued on page 216*)

TELEPHONE DEVELOPMENT OF LARGE CITIES

January 1, 1949

Data relate in general to exchange or zone areas of the cities served.
Usually such areas are larger than the corporate areas.

Country and City (or Exchange Area)	Estimated Population (In Thousands)	Number of Telephones	Telephones per 100 Population
ALGERIA:			
Algiers	314	27,913	8.9
Constantine	119	3,561	3.0
Oran	253	12,124	4.8
ARGENTINA:			
Buenos Aires	4,205	424,003	10.1
Cordoba	352	17,072	4.9
Rosario	465	35,668	7.7
AUSTRALIA:			
Adelaide	394	54,328	13.8
Brisbane	412	62,386	15.1
Hobart	79	11,477	14.5
Melbourne	1,260	215,855	17.1
Newcastle	130	11,427	8.8
Perth	282	34,630	12.3
Sydney	1,525	250,285	16.4
BELGIUM:			
Antwerp	575	62,151	10.8
Brussels	932	200,236	21.5
Charleroi	274	24,500	8.9
Ghent	216	20,864	9.7
Liége	365	39,037	10.7
Verviers	77	13,659	17.7
BRAZIL:			
Rio de Janeiro	2,217	187,501	8.5
Santos	219	12,175	5.6
São Paulo	1,776	101,134	5.7
CANADA:			
Hamilton	197	58,392	29.6
London	105	33,253	31.7
Montreal	1,285	331,958	25.8
Ottawa	278	74,031	26.6
Quebec	206	49,332	23.9
Toronto	912	348,361	38.2
Vancouver	414	120,943	29.2
Victoria	104	28,001	26.9
Windsor	149	36,282	24.4
Winnipeg	362	82,855	22.9
CHILE:			
Santiago	1,137	69,294	6.1
Valparaiso	183	9,192	5.0
CHINA:			
Shanghai	4,500	93,500	2.1
CUBA:			
Havana	910	70,858	7.8
DENMARK:			
Aalborg	64	14,325	22.4
Aarhus	113	24,371	21.6
Copenhagen	971	299,112	30.8
Odense	97	18,067	18.6
FINLAND:			
Helsinki	385	87,986	22.9
Tampere	98	8,820	9.0
Turku	103	11,439	11.1
FRANCE:			
Bordeaux	255	32,557	12.8
Lille	211	22,652	10.7
Lyon	546	62,955	11.5
Marseille	638	55,781	8.7
Nantes	202	16,013	7.9
Nice	213	21,590	10.1
Paris	2,750	569,847	20.7
Rouen	109	14,306	13.1
Strasbourg	177	15,585	8.8
Toulouse	266	18,120	6.8
GERMANY:			
Berlin [a]	2,056	69,006	3.4
Bremen	348	30,921	8.9
Cologne	546	32,505	6.0
Dusseldorf	466	43,676	9.4
Frankfort-on-Main	586	49,250	8.4
Hanover	455	30,202	6.6
Hamburg-Altona	1,545	157,459	10.2
Munich	860	53,913	6.3
Nuremburg	497	27,073	5.4
Stuttgart	558	35,460	6.4
HAWAII:			
Honolulu	275	66,631	24.2
ICELAND:			
Reykjavik	55	10,105	18.4
INDIA:			
Bombay	3,700	33,092	0.9
Calcutta	5,900	30,990	0.5
IRELAND:			
Cork	75	3,676	4.9
Dublin	520	38,325	7.4
ISRAEL:			
Tel Aviv	220	7,780	3.5
ITALY:			
Bologna	283	21,862	7.7
Catania	286	7,968	2.8

[a] Excluding Russian Sector of Berlin.
[b] March 31, 1949. [c] June 30, 1948.

TELEPHONE DEVELOPMENT OF LARGE CITIES—Continued

Country and City (or Exchange Area)	Estimated Population (In Thousands)	Number of Telephones	Telephones per 100 Population
ITALY (continued):			
Florence	320	34,595	10.8
Genoa	374	49,281	13.2
Milan	1,268	191,050	15.1
Naples	886	27,515	3.1
Palermo	459	12,090	2.6
Rome	1,534	205,556	13.4
Turin	704	75,318	10.7
Venice	195	15,920	8.2
JAMAICA:			
Kingston	260	8,739	3.4
JAPAN:[b]			
Fukuoka	348	12,061	3.5
Hiroshima	246	4,505	1.8
Kanazawa	237	11,130	4.7
Kobe	644	18,622	2.9
Kyoto	1,040	56,334	5.4
Nagoya	995	28,896	2.9
Osaka	1,689	74,379	4.4
Sapporo	269	12,697	4.7
Tokio	5,417	193,839	3.6
Yokohama	859	21,998	2.6
LUXEMBURG:			
Luxemburg	62	8,863	14.3
MEXICO:			
Guadalajara	283	11,398	4.0
Mexico, D. F.	1,890	133,114	7.0
Monterrey	253	12,950	5.1
Puebla	160	9,623	6.0
NETHERLANDS:			
Amsterdam	827	88,416	10.7
Arnhem	101	9,559	9.5
Eindhoven	138	8,581	6.2
Groningen	147	14,611	9.9
Haarlem	205	18,850	9.2
The Hague	610	78,284	12.8
Leiden	105	9,422	9.0
Nijmegen	115	7,643	6.6
Rotterdam	737	62,910	8.5
Utrecht	208	19,839	9.5
NETHERLANDS INDIES:			
Bandoeng	405	2,945	0.7
NEW ZEALAND:[b]			
Auckland	291	45,531	15.6
Christchurch	168	25,342	15.1
Dunedin	87	16,494	19.0
Wellington	187	44,905	24.0
NORWAY:[c]			
Bergen	110	25,154	22.9
Oslo	426	104,867	24.6
Stavanger	50	13,011	26.0
Trondheim	57	14,307	25.1
PAKISTAN:			
Karachi	1,000	4,968	0.5
PARAGUAY:			
Asunción	137	4,298	3.1
PERU:			
Callao	100	2,321	2.3
Lima	680	30,831	4.5
PHILIPPINE REPUBLIC:			
Manila	983	8,771	0.9
POLAND:			
Warsaw	607	14,000	2.3
PUERTO RICO:			
San Juan	231	15,673	6.8
SPAIN:			
Barcelona	1,250	85,913	6.9
Bilbao	230	18,302	8.0
Madrid	1,300	122,067	9.4
San Sebastian	110	11,165	10.2
Seville	400	15,787	3.9
Valencia	535	17,901	3.3
Zaragoza	270	11,205	4.2
SWEDEN:			
Borås	56	14,335	25.6
Göteborg	344	109,420	31.8
Hälsingborg	71	16,963	23.9
Linköping	52	13,243	25.5
Malmö	186	51,868	27.9
Norroköping	83	20,262	24.4
Örebro	65	19,020	29.3
Stockholm	726	330,383	45.5
Uppsala	60	17,447	29.1
Västerås	56	13,829	24.7
SWITZERLAND:			
Basel	181	65,575	36.2
Bern	142	57,427	40.4
Geneva	149	50,462	33.9
Lausanne	105	33,003	31.4
Lucerne	60	20,510	34.2
St. Gallen	67	17,248	25.7
Winterthur	65	12,305	18.9
Zurich	383	124,525	32.5
TRINIDAD AND TOBAGO:			
Port of Spain	100	7,503	7.5
TUNISIA:			
Tunis	400	13,005	3.3
UNION OF SOUTH AFRICA:			
Bloemfontein	89	6,185	6.9
Capetown	511	54,430	10.7
Durban	406	38,008	9.4

TELEPHONE DEVELOPMENT OF LARGE CITIES—Continued

Country and City (or Exchange Area)	Estimated Population (In Thousands)	Number of Telephones	Telephones per 100 Population
UNION OF SOUTH AFRICA (continued):			
East London	85	5,861	6.9
Germiston	147	4,638	3.2
Johannesburg	841	96,010	11.4
Kimberley	60	2,571	4.3
Pietermaritzburg	67	6,790	10.1
Port Elizabeth	160	13,098	8.2
Pretoria	277	27,165	9.8
UNITED KINGDOM: [b]			
Belfast	453	34,200	7.5
Birmingham	1,292	115,930	9.0
Bristol	455	47,672	10.5
Cardiff	248	22,098	8.9
Edinburgh	490	70,918	14.5
Glasgow	1,217	105,331	8.7
Kingston upon Hull	346	35,108	10.1
Leeds	581	58,072	10.0
Leicester	282	30,180	10.7
Liverpool	1,429	114,453	8.0
London, Greater	8,350	1,470,507	17.6
City and County of	3,374	819,670	24.3
Manchester	1,265	124,500	9.8
Nottingham	427	41,260	9.7
Newcastle on Tyne	521	42,860	8.2
Sheffield	512	41,801	8.2
URUGUAY:			
Montevideo	750	55,879	7.5
VENEZUELA:			
Caracas, D. F.	450	39,506	8.8
UNITED STATES:			
Akron, O.	397	131,246	33.0
Alameda, Cal.	(Included in Oakland)		
Albany, N. Y.	174	71,258	41.0
Albuquerque, N. M.	95	27,110	28.5
Alhambra, Cal.	150	39,607	26.4
Allentown, Pa.	125	39,574	31.5
Altoona, Pa.	99	27,363	27.6
Amarillo, Tex.	84	27,013	32.2
Anderson, Ind.	65	21,188	32.4
Asheville, N. C.	86	22,889	26.5
Atlanta, Ga.	590	181,735	30.8
Atlantic City, N. J.	87	38,973	44.9
Augusta, Ga.	139	27,850	20.0
Aurora, Ill.	62	22,288	35.8
Austin, Tex.	151	46,170	30.7
Baltimore, Md.	1,046	286,483	27.4
Baton Rouge, La.	164	37,980	23.1
Bay City, Mich.	72	21,745	30.0
Bayonne, N. J.	85	18,935	22.3
Beaumont, Tex.	136	29,918	22.0
Berkeley, Cal.	(Included in Oakland)		
Berwyn, Ill.	60	15,734	26.2
Bethlehem, Pa.	78	25,142	32.1
Binghamton, N. Y.	102	33,293	32.8
Birmingham, Ala.	460	111,347	24.2

Country and City (or Exchange Area)	Estimated Population (In Thousands)	Number of Telephones	Telephones per 100 Population
UNITED STATES (continued):			
Boston, Mass.	741	288,947	39.0
Bridgeport, Conn.	214	73,268	34.3
Brockton, Mass.	77	23,113	30.0
Brookline, Mass.	87	34,908	40.4
Buffalo, N. Y.	720	235,152	32.7
Burbank, Cal.	98	33,255	34.1
Cambridge, Mass.	117	44,686	38.1
Camden, N. J.	131	35,602	27.2
Canton, O.	154	49,971	32.5
Cedar Rapids, Ia.	76	28,867	37.9
Charleston, S. C.	145	27,136	18.7
Charleston, W. Va.	127	39,383	31.0
Charlotte, N. C.	170	48,270	28.4
Chattanooga, Tenn.	232	61,768	26.6
Chester, Pa.	104	27,705	26.6
Chicago, Ill.	3,725	1,460,368	39.2
Cicero, Ill.	73	23,563	32.3
Cincinnati, O.	662	225,131	34.0
Cleveland, O.	1,289	496,400	38.5
Cleveland Heights, O.	(Included in Cleveland)		
Clifton, N. J.	(Included in Passaic)		
Columbia, S. C.	149	31,253	21.0
Columbus, Ga.	134	28,397	21.2
Columbus, O.	432	165,088	38.2
Corpus Christi, Tex.	132	33,221	25.2
Covington, Ky.	158	40,991	26.0
Cranston, R. I.	(Included in Providence		
Dallas, Tex.	544	195,245	35.9
Davenport, Ia.	91	30,457	33.3
Dayton, O.	326	121,459	37.3
Dearborn, Mich.	(Included in Detroit)		
Decatur, Ill.	85	27,109	31.9
Denver, Colo.	415	176,832	42.6
Des Moines, Ia.	212	78,042	36.9
Detroit, Mich.	2,236	791,764	35.4
Duluth, Minn.	116	40,202	34.8
Durham, N. C.	85	19,791	23.3
East Chicago, Ind.	60	13,365	22.3
East Orange, N. J.	144	50,159	34.9
East St. Louis, Ill.	102	22,699	22.3
Elizabeth, N. J.	128	38,308	29.9
El Paso, Tex.	144	34,738	24.1
Erie, Pa.	145	40,753	28.2
Evanston, Ill.	73	33,181	45.3
Evansville, Ind.	161	47,405	29.5
Fall River, Mass.	143	32,527	22.8
Flint, Mich.	219	67,531	30.9
Fort Wayne, Ind.	136	57,733	42.5
Fort Worth, Tex.	346	103,600	29.9
Fresno, Cal.	146	48,503	33.3
Gadsden, Ala.	73	11,674	16.1
Galveston, Tex.	86	26,242	30.5
Gary, Ind.	153	36,041	23.5
Glendale, Cal.	104	36,438	35.0
Grand Rapids, Mich.	262	91,461	34.9
Greensboro, N. C.	115	28,536	24.8
Hamilton, O.	73	20,376	27.9

TELEPHONE DEVELOPMENT OF LARGE CITIES—Continued

Country and City (or Exchange Area)	Estimated Population (In Thousands)	Number of Telephones	Telephones per 100 Population
UNITED STATES (continued):			
Hammond, Ind.	80	21,173	26.6
Hamtramck, Mich.	(Included in Detroit)		
Harrisburg, Pa.	148	59,320	40.1
Hartford, Conn.	294	117,838	40.0
Highland Park, Mich.	(Included in Detroit)		
Hoboken, N. J.	(Included in Jersey City)		
Holyoke, Mass.	85	23,762	28.0
Houston, Tex.	678	227,761	33.6
Huntington, W. Va.	93	30,346	32.6
Indianapolis, Ind.	538	194,923	36.3
Irvington, N. J.	(Included in Newark)		
Jackson, Mich.	89	30,750	34.4
Jackson, Miss.	117	31,820	27.2
Jacksonville, Fla.	302	65,522	21.7
Jersey City, N. J.	365	90,813	24.9
Johnstown, Pa.	112	23,602	21.1
Kalamazoo, Mich.	96	37,198	38.9
Kansas City, Kans.	(Included in Kansas City, Mo.)		
Kansas City, Mo.	681	248,597	36.5
Knoxville, Tenn.	229	53,672	23.5
Lakewood, O.	(Included in Cleveland)		
Lancaster, Pa.	93	31,676	34.0
Lansing, Mich.	132	52,874	40.1
Lawrence, Mass.	121	30,047	24.9
Lexington, Ky.	96	23,552	24.5
Lincoln, Neb.	104	38,998	37.5
Little Rock, Ark.	178	51,367	28.8
Long Beach, Cal.	296	99,554	33.6
Los Angeles, Cal.	2,000	793,758	39.7
Louisville, Ky.	458	138,957	30.4
Lowell, Mass.	126	30,144	24.0
Lubbock, Tex.	75	18,042	23.9
Lynn, Mass.	142	44,022	30.9
Macon, Ga.	120	28,245	23.6
Madison, Wis.	102	43,825	43.2
Malden, Mass.	61	17,715	29.0
Manchester, N. H.	86	24,265	28.2
McKeesport, Pa.	118	30,158	25.5
Medford, Mass.	62	16,323	26.4
Memphis, Tenn.	429	131,302	30.6
Miami, Fla.	521	157,416	30.2
Miami Beach, Fla.	(Included in Miami)		
Milwaukee, Wis.	868	280,352	32.3
Minneapolis, Minn.	628	253,076	40.3
Mobile, Ala.	196	39,658	20.2
Montgomery, Ala.	159	28,164	17.7
Mt. Vernon, N. Y.	76	26,069	34.1
Muncie, Ind.	69	22,922	33.1
Nashville, Tenn.	288	87,698	30.4
Newark, N. J.	546	178,434	32.7
New Bedford, Mass.	144	38,270	26.6
New Britain, Conn.	87	25,586	29.5
New Castle, Pa.	71	20,612	28.9
New Haven, Conn.	259	95,736	37.0
New Orleans, La.	683	189,723	27.8
New Rochelle, N. Y.	64	23,120	36.2

Country and City (or Exchange Area)	Estimated Population (In Thousands)	Number of Telephones	Telephones per 100 Population
UNITED STATES (continued):			
Newton, Mass.	78	29,985	38.4
New York, N. Y.	7,944	2,768,567	34.8
Niagara Falls, N. Y.	92	30,004	32.7
Norfolk, Va.	218	69,357	31.8
Oakland, Cal.	697	262,211	37.6
Oak Park, Ill.	71	26,924	37.9
Ogden, Utah	88	23,868	27.1
Oklahoma City, Okla.	273	104,644	38.3
Omaha, Neb.	293	104,941	35.9
Orlando, Fla.	81	21,015	25.9
Pasadena, Cal.	180	72,354	40.2
Passaic, N. J.	175	42,383	24.3
Paterson, N. J.	181	50,866	28.1
Pawtucket, R. I.	138	31,037	22.6
Peoria, Ill.	176	56,619	32.2
Philadelphia, Pa.	2,100	696,027	33.1
Phoenix, Ariz.	230	55,552	24.2
Pittsburgh, Pa.	1,034	372,255	36.0
Pittsfield, Mass.	61	20,772	34.3
Pontiac, Mich.	119	39,616	33.4
Port Arthur, Tex.	96	20,927	21.8
Portland, Me.	119	38,904	32.8
Portland, Ore.	489	181,861	37.2
Portsmouth, Va.	86	20,549	23.9
Providence, R. I.	389	117,856	30.3
Pueblo, Colo.	94	23,666	25.2
Quincy, Mass.	84	27,177	32.4
Racine, Wis.	86	27,540	31.9
Raleigh, N. C.	93	25,525	27.4
Reading, Pa.	149	50,199	33.6
Richmond, Cal.	137	19,627	14.3
Richmond, Va.	265	98,588	37.2
Riverside, Cal.	66	18,819	28.5
Roanoke, Va.	112	33,966	30.3
Rochester, N. Y.	415	132,602	32.0
Rockford, Ill.	135	44,821	33.2
Rock Island, Ill.	52	16,947	32.6
Sacramento, Cal.	212	75,552	35.6
Saginaw, Mich.	118	37,089	31.4
St. Joseph, Mo.	98	28,654	29.2
St. Louis, Mo.	1,059	360,326	34.0
St. Paul, Minn.	367	139,024	37.9
St. Petersburg, Fla.	115	30,977	26.9
Salt Lake City, Utah	240	78,264	32.6
San Antonio, Tex.	459	106,437	23.2
San Bernardino, Cal.	73	20,829	28.5
San Diego, Cal.	355	100,423	28.3
San Francisco, Cal.	841	417,133	49.6
San Jose, Cal.	152	46,858	30.8
Santa Monica, Cal.	148	44,212	29.9
Savannah, Ga.	148	33,672	22.8
Schenectady, N. Y.	143	55,372	38.8
Scranton, Pa.	166	41,970	25.3
Seattle, Wash.	603	248,189	41.2
Shreveport, La.	190	49,132	25.9
Sioux City, Ia.	91	29,374	32.2
Somerville, Mass.	102	23,536	23.1
South Bend, Ind.	188	58,166	31.0

TELEPHONE DEVELOPMENT OF LARGE CITIES—Continued

Country and City (or Exchange Area)	Estimated Population (In Thousands)	Number of Telephones	Telephones per 100 Population
UNITED STATES (continued)			
Spokane, Wash.	201	68,357	34.0
Springfield, Ill.	99	37,665	38.0
Springfield, Mass.	213	75,338	35.4
Springfield, Mo.	99	28,823	29.2
Springfield, O.	94	30,798	32.7
Stamford, Conn.	71	28,969	41.1
Stockton, Cal.	117	33,881	29.0
Syracuse, N. Y.	255	93,911	36.8
Tacoma, Wash.	196	62,761	32.0
Tampa, Fla.	200	48,553	24.3
Terre Haute, Ind.	103	24,288	23.6
Toledo, O.	376	128,460	34.2
Topeka, Kans.	107	36,418	33.9
Trenton, N. J.	196	54,177	27.7
Troy, N. Y.	82	23,696	28.8
Tucson, Ariz.	119	26,912	22.6
Tulsa, Okla.	211	89,373	42.4
UNITED STATES (continued)			
Union City, N. J.	173	42,492	24.5
Utica, N. Y.	133	39,002	29.3
Waco, Tex.	112	24,596	22.0
Washington, D. C.	938	447,283	47.7
Waterbury, Conn.	115	39,582	34.5
Waterloo, Ia.	69	22,941	33.3
Wheeling, W. Va.	72	24,846	34.6
Wichita, Kans.	200	72,364	36.2
Wichita Falls, Tex.	67	21,417	32.0
Wilkes-Barre, Pa.	131	30,736	23.5
Wilmington, Del.	162	62,601	38.6
Winston-Salem, N. C.	127	29,500	23.3
Woonsocket, R. I.	70	18,598	26.6
Worcester, Mass.	220	71,292	32.4
Yonkers, N. Y.	148	41,845	28.2
York, Pa.	103	20,423	19.9
Youngstown, O.	224	68,498	30.6

as being operated either wholly or preponderantly under government ownership rank in respect of the number of their telephones as follows: The United Kingdom, Germany, France, Sweden, U. S. S. R. However, in the aggregate, these five countries are served by only one-third the number of telephones found in the United States alone.

Telephones in Large Cities

IN POINT of relative telephone development, San Francisco leads the large cities of the world with 49.6 telephones per 100 of its population, followed by Washington, D. C. with 47.7. Highest among foreign cities is Stockholm, with 45.5 per 100 inhabitants, while Bern is next with 40.4.

New York, with 2,768,567 telephones; Chicago, with 1,460,368; and Greater London, with 1,470,507, are the only cities in the world having more than one million telephones. In fact, there are but eight *countries* outside the United States having more than one million telephones.

New York City alone has more telephones than have Greater London, Paris, Stockholm, Rome, and Madrid combined.

THAT the telephone has become an integral part of our social and business lives is evidenced by the fact that the number of telephone messages per capita in the United States averaged 346 during 1948. This figure compares with 301 for Sweden, which has the greatest telephone density outside the United States, and with 63.4 for the second largest telephone system in the world, that of the United Kingdom.

The wide usage of this country's telephones and their rapid growth in the post-war years reflect the increasing value of the service at a price within the reach of millions of people.

Planning Ahead for Facilities in Homes and Commercial Buildings Results in Unobtrusive Wiring and Efficient Location of Instruments and Equipment

Advance Arrangements for Telephone Convenience

Adolph F. Michel and T. Hunt Clark

THE POST-WAR BOOM in home building is bringing about a type of residence which is radically different from that of twenty-five years ago. Houses are constructed of new materials to new designs and provide new conveniences, to meet people's desire for better living: better heating, better lighting, better ventilation, increased ease, more attractive appearance.

In a house designed for more efficient functioning, telephones at convenient locations, and enough telephones, can contribute to labor saving and step saving—to ease and convenience—in the same way as can a "science" kitchen. And the same arrangements which make this possible can also avoid exposed telephone wiring which otherwise might mar the appearance of tastefully decorated rooms—no matter how neatly the installer worked.

Nor are these things difficult of accomplishment. All they require is a bit of forethought and some advance planning.

The Bell System, because it realizes its responsibility to help its customers get the most and the best service for their money, stands ready to help with the job of planning *in time* for service in homes. What is more, it campaigns to remind people that they will be the gainers by the planning.

In each of the operating companies of the Bell System, an Architects and Builders Service is maintained, to advise and assist architects, builders, prospective home owners, and others who might be interested in getting the benefits of advance telephone planning. Representatives of the Commercial, Engineering, and Plant Departments are designated to act as consultants. A call or letter

TELEPHONE WIRES

DON'T SHOW ON THE FACE OF IT

With a little planning, you can avoid exposed telephone wires on walls, woodwork and partitions in your new home.

Just mark on your plans the places where you'll want telephone outlets. Then, while the house is being built, your builder can place a few lengths of pipe or tubing inside the walls to carry concealed telephone wires to the built-in outlets.

For further information about this important home feature, call your nearest Bell Telephone Business Office and ask for "Architects and Builders Service."

BELL TELEPHONE SYSTEM

MARCEL BREUER, Architect

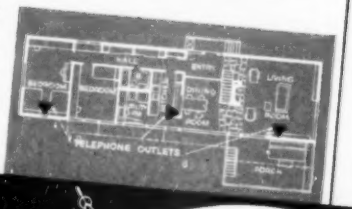
HOMES WITH A FUTURE HAVE TELEPHONE RACEWAYS

lern home planning considers the e as well as the present needs of owner. Telephone raceways con- telephone wires within walls. They provide for the relocation or ion of telephones later on.

easy and inexpensive to provide ephone facilities during construc- few lengths of pipe or tubing in the walls will carry telephone o outlets located at key points out the house.

Bell Telephone Cor to co-operate in pla ceway systems. Ju telephone compan nd ask for "Arch ervice."

LEPHONE SYST



Include.. T. C.* in your BUILDING PLANS

***T. C. means**

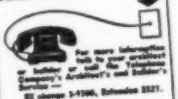
Telephone Conduit

which means

Telephone Convenience

— in your new home.

To eliminate exposed wires, have telephone conduit installed inside the walls to carry telephone wires to outlets like this.....



For more information talk to your architect or builder or call the Telephone Company's Architect's and Builder's Service —

BE change 3-1200, Extension 2521.

WISCONSIN TELEPHONE COMPANY

Building a new home?

Then you'll want this booklet on concealing telephone wires Just call or write for your *Free* copy

Just write or call our "Architects' & Builders' Service"

THE OHIO BELL TELEPHONE COMPANY

Advertisements such as these bring the advantages of advance planning for telephone convenience to the attention of architects, builders, and prospective home owners

to the Architects and Builders Service will bring helpful and practical leaflets and other information, and the prospective home owner and his architect or builder may come in for an interview with the telephone experts if a problem seems to warrant it.

This service is given without charge, of course. Moreover, the System makes a definite effort to bring it to the attention of people to whom it would be helpful. Advertisements are run in national magazines of interest to home owners and to the professional field; displays are exhibited at "own your own home" shows and similar conventions, and booklets are furnished; and calls are made on architects and builders, who are provided with reference material for their files and binders.

This kind of activity isn't new; it has been going on, as a matter of fact, for years. And it does bear fruit. A recent instance in the territory of one Associated Company concerns three contractors who were putting up a total of about 4,800 houses in the $6,000–$10,000 cost range. These firms were interviewed and the advantages of providing up-to-date telephone equipment were em-

Telephone Company displays at "own your own home" shows and similar expositions dramatize the benefits of planning ahead for telephone service

phasized. When the houses were completed, more than three-fourths of the recommended facilities had been installed.

Locations for Telephones in Homes

CUSTOMERS want telephones located where they will be most convenient to use. Preferences will vary, naturally, but the most popular locations for telephone outlets are in or near the living and working areas where the occupants spend most of their time. Experience shows that the kitchen or dining alcove, the master bedroom, guest room or other bedrooms, living room, den or study, recreation room or workshop, are included in the preferred locations. One or more of these rooms are selected for telephones.

Bedside telephones are becoming more and more popular. An added reason is that telephone bells can be adjusted to ring very softly.

For real telephone convenience, at least one telephone outlet should be installed on each level of the house. Inasmuch as every future telephone need may not now be foreseen, it is better to have too many outlets than too few, since as time goes by requirements for service often increase. Providing extra outlets is good home planning.

In addition to the permanently located telephone instrument, many home owners have portable telephones which may be carried from room to room and plugged into outlets which are equipped with jacks, particularly in rooms which are used only on occasion. Guest rooms, sewing room, laundry, workshop, and basement recreation room come under this category. Such outlets are also popular in seasonal rooms or locations, including sun rooms, terraces, and porches. A portable telephone may be used on a screened porch during the summer and then transferred to the basement or any other jack outlet in the winter.

Service Entrance

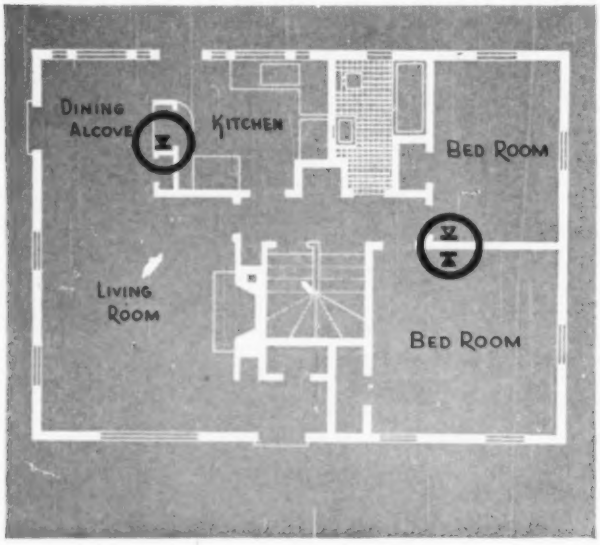
A SERVICE ENTRANCE conduit or pipe sleeve for bringing the service wires into the building is very desirable, since this precludes the necessity for drilling holes through difficult surfaces or materials. A conduit between the point where the aerial drop wire is to be attached to the building and the protector is desirable both from the standpoint of appearance and as a protection against tampering by unauthorized persons. The location for the service entrance should, of course, be checked with the telephone company before it is provided.

In order to eliminate exposed wires outside, not only for the sake of appearance but to minimize service interruptions from storms or other causes, some home owners find it advantageous to have the telephone entrance wires underground. As available plant facilities, local municipal regulations, and other factors require coördination of all phases of the work, it is important that the telephone company be consulted before planning construction of an underground entrance.

Protector Cabinet

THE TELEPHONE LINE entering the home generally must be connected to a station protector to prevent possible excessive voltages from power circuits or lightning from reaching

Such booklets illustrate practical suggestions



Telephone outlets should be planned for the working and living areas of the home

the inside wiring or station apparatus. This protector is usually located in the basement or attic near the point the telephone wires will enter the building. If located in a finished basement, the protector should be concealed by a cabinet. Steel boxes, like those used for mounting electrical switches, are suitable and can be recessed in the basement ceiling or on an outside wall.

Wiring Channels

TELEPHONE OUTLETS should be connected by wiring channels to some part of the basement or attic where exposed wires will not be noticeable. In many homes this means merely running a few feet of pipe within a wall to an unfinished part of the basement or accessible part of the attic. In homes without basements, or where the basement is finished as a play room, it is desirable to extend the pipe raceway to the protector cabinet near the service entrance.

In certain localities, wires are not run under houses because of extreme moisture conditions, and the raceways from the outlets are then run to the attic. The attic must, of course, be accessible to the telephone installer.

It is usually a good idea to extend a raceway in a two-story house to the attic even though it originates in an unfinished basement. Then, if a telephone is needed later in one of the rooms without an outlet, the wire can be dropped through a closet to the new location.

Almost any kind of pipe or tubing can be used for raceways, but since iron pipe or thin wall electrical tubing is usually available on the site, these are the materials most frequently used. The outlets provided for bringing out the telephone wires are commercially available shallow iron boxes such as those used to contain lighting switches. The outlet box is closed with a commercial cover plate with a round bushed or grommeted hole for the telephone set cord or wire entrance—except where outlets equipped with jacks for portable telephones are to be provided. In this case the jacks (not the outlet box) and associated cover plates are furnished by the telephone company.

If a double outlet (two boxes fastened back to back) is used, it is often

possible to arrange to make one raceway do double duty too by serving two adjoining rooms.

Each home naturally requires its custom-tailored telephone arrangement, but even the simplest layout should include enough outlets in the right places, with raceways from the outlets to unfinished parts of the basement or attic.

Commercial and Industrial Buildings

THE DESIRABILITY of planning in advance of construction for telephone and other communication services in commercial and industrial buildings has been generally recognized for many years. If proper facilities are provided, the general appearance of the building and its offices is improved and the wires and cables are afforded mechanical protection. The latter serves to prevent service interruptions, and provides the flexibility which makes possible rearrangements and changes in the circuit terminations without the need for drilling holes through finished walls and floors, exposing wires and cables in offices and halls and marring walls and trim —all to the general inconvenience and annoyance of tenants.

It is of the utmost importance that the expert advice of the Architects and Builders Service be obtained at a very early stage of the undertaking.

General requirements for commercial and industrial buildings include cable service entrances, main cross-connecting terminal and other cable terminals, riser conduits and riser shafts, floor distribution systems, and space for telephone and related equipment.

Service Entrances

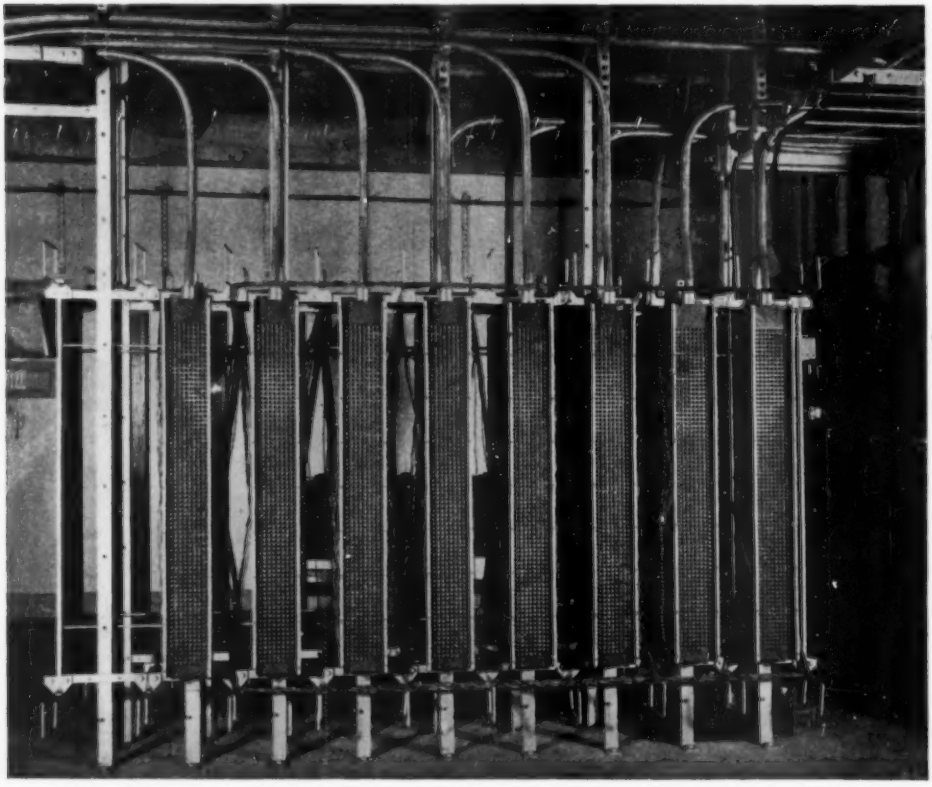
TELEPHONE ENTRANCE CABLES are usually run from a manhole in the street through the foundation wall to a cross-connecting terminal in the basement of the building. Available underground facilities often con-

Interior raceways in homes bring concealed telephone wires to outlets for telephones at convenient locations

trol selection of the entrance point, and in certain cases an overhead instead of underground telephone distribution system may be involved. In some instances, basements may be subject to excessive dampness or flooding, and the cross-connecting terminals would have to be placed higher in the building.

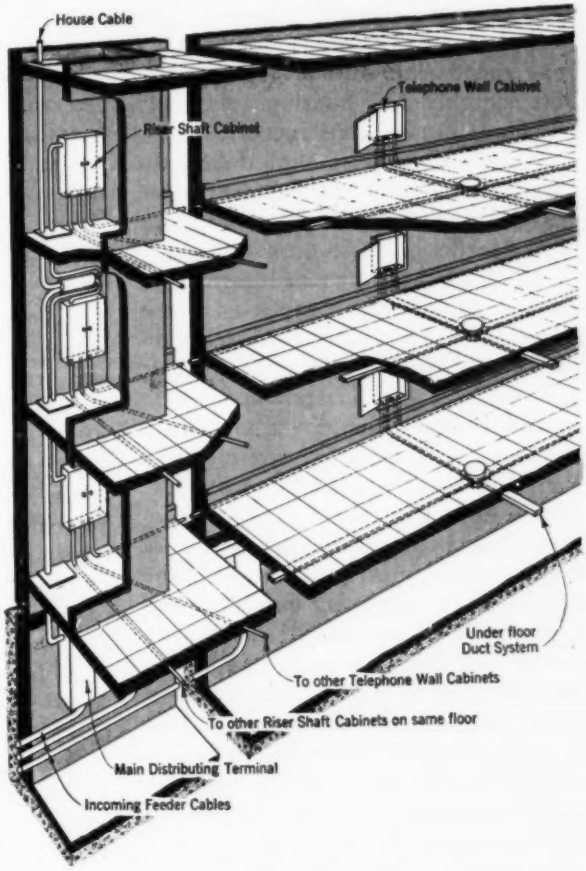
In any case, a sufficient number of iron pipes, sleeves, or clay sewer tiles to care for the ultimate number of cables entering the building are generally placed in foundation or other walls during construction. These holes are always kept sealed to avoid entrance of water.

Incoming service cables usually terminate on a cross-connecting terminal of either the wall or frame type. At this point, cross-connections are made to house cables which extend through conduits or riser shafts to all floors of the building. The floor-type terminal, rather than the wall type, is usually provided in the larger buildings having a considerable number of telephone stations and other communication services, and special fireproof terminal rooms are very desirable. They avoid possibility of large-scale interruptions to service from careless handling of materials or merchandise or a minor fire.



The cross-connecting terminal for the telephone wires serving a large building normally requires a separate terminal room

The cross-connecting terminal should be located near the center of the cable distribution system, so as to minimize the amount of cable used. In certain buildings, such as hotels, this center would be on one of the lower floors, where the private branch switchboard is located.



Provision for a telephone distribution system as extensive as this must be included in the original plans

Riser Conduits and Riser Shafts

RISER CONDUITS are not usually employed in buildings exceeding 12 stories in height nor in buildings of less height that cover a large area, as advantages of so protecting the cables are offset by difficulty in installing and supporting heavy cables in conduits and making complicated splices in the cabinets associated with the conduit system.

Riser shafts should start from the floor on which the cross-connecting terminal is located and extend throughout the building. If the shaft cannot be made continuous, conduits of adequate size should be provided to connect the top of one riser shaft to the bottom of the one above it or to the cross-connecting terminal, so as to provide continuous cable runs throughout the building. Riser shaft closets are normally placed one above the other throughout the full height of the building. Such closets are quite wide and long and have full ceiling height. A large slot or large iron pipe sleeves should be provided in the floor of the shaft, to permit raising full-sized cables with splices in the shaft.

Floor Distribution Systems

THE RISER SHAFT CLOSET containing a cable terminal is the main distribution point for a rather large floor area and it is often impracticable to carry all telephone and telegraph wiring directly back to this terminal. For this reason, adequate wiring facilities always provide for distribu-

tion terminals about the floors. The best appearing and most desirable arrangement is to furnish built-in cabinets suitable for housing telephone terminals during construction.

Each wall cabinet should be connected by conduits to the nearest riser shaft, adjacent wall cabinets, and to the underfloor distribution system.

The logical permanent location for electric wiring of all types is in the floor, for the reason that interior dividing partitions are often omitted or are made readily interchangeable in most commercial buildings, and other supports are quite restrictive and their use may be prohibited by law. Under-floor raceways consist of conduits, ducts, or cellular steel floor—whichever is most suitable for the needs of the particular building; and a separate system must be provided for the telephone wiring. Since the standard office desk is the unit on which the telephone, business machine, and often lights are to be established, and the desks may be located anywhere on the floor, the need for under-floor wire distribution systems is acute. The raceways are usually placed five to six feet apart to correspond with the desk length and the outlets 24 inches apart on each raceway to permit any desired spacing between desks.

Under-floor conduit systems are suitable for small buildings not having need for many telephone and telegraph circuits out in the open spaces. In buildings with permanent partitions and walls, they may be supplemented by a number of different baseboard raceway systems.

Two types of under-floor duct systems are commonly provided, either steel or fibre. The number of raceways in a given system depends on service requirements.

Cellular steel floors are also used for wire distribution systems. The longitudinal cells in these floors are connected to wall cabinets by header ducts which cross above the cells.

Space for Equipment

PLANNING the right locations for residence telephones presents only minor problems. But large commercial structures are likely to have to arrange space for a number of items of telephone equipment of various kinds and sizes and uses. These include such things as private branch switchboards large and small, order-receiving equipment, teletypewriters, and perhaps alarm or announcing or paging systems. Many buildings will also have need for public telephones, with booths in all probability, and their location will call for careful planning.

Such specialized equipment and its location is beyond the scope of this paper. But it is by no means beyond the scope of the Associated Company groups who are concerned with planning customers' facilities; it is, indeed, right down their alley. And the importance, the necessity even, of architect and contractor and owner seeking their counsel is self-evident.

Whether it be a modest "ranch-type" bungalow or a glass-and-chromium skyscraper, the telephone company can add much to its comfort, its livability, its efficiency—if given the opportunity. The Architects and Builders Service is another Bell System practice which adds a *plus* to the value of the dollar the customer pays for his telephone service.

Lines Built Primarily to Aid Hydraulic Mining in the Mother Lode Country Also Provided for Some Public Use In the First Years of the Telephone's Growth

Some Early Long Distance Lines in the Far West

Walter Blackford, Sr., and Joy F. Hutton

HISTORICAL RESEARCH, by its nature, cannot be an exact science. The investigator who shouts, "Eureka! I have found the first!" is all too often preparing himself for a rude shock. Sooner or later, new evidence turns up to make a monkey out of him.

The beginnings of long distance telephone service are no exception to this generalization. In studying the early California and Nevada lines discussed here, we* have followed a dim and dusty trail back through the years. Beyond a doubt, we have traced out some of the earliest long distance telephone lines in the world.

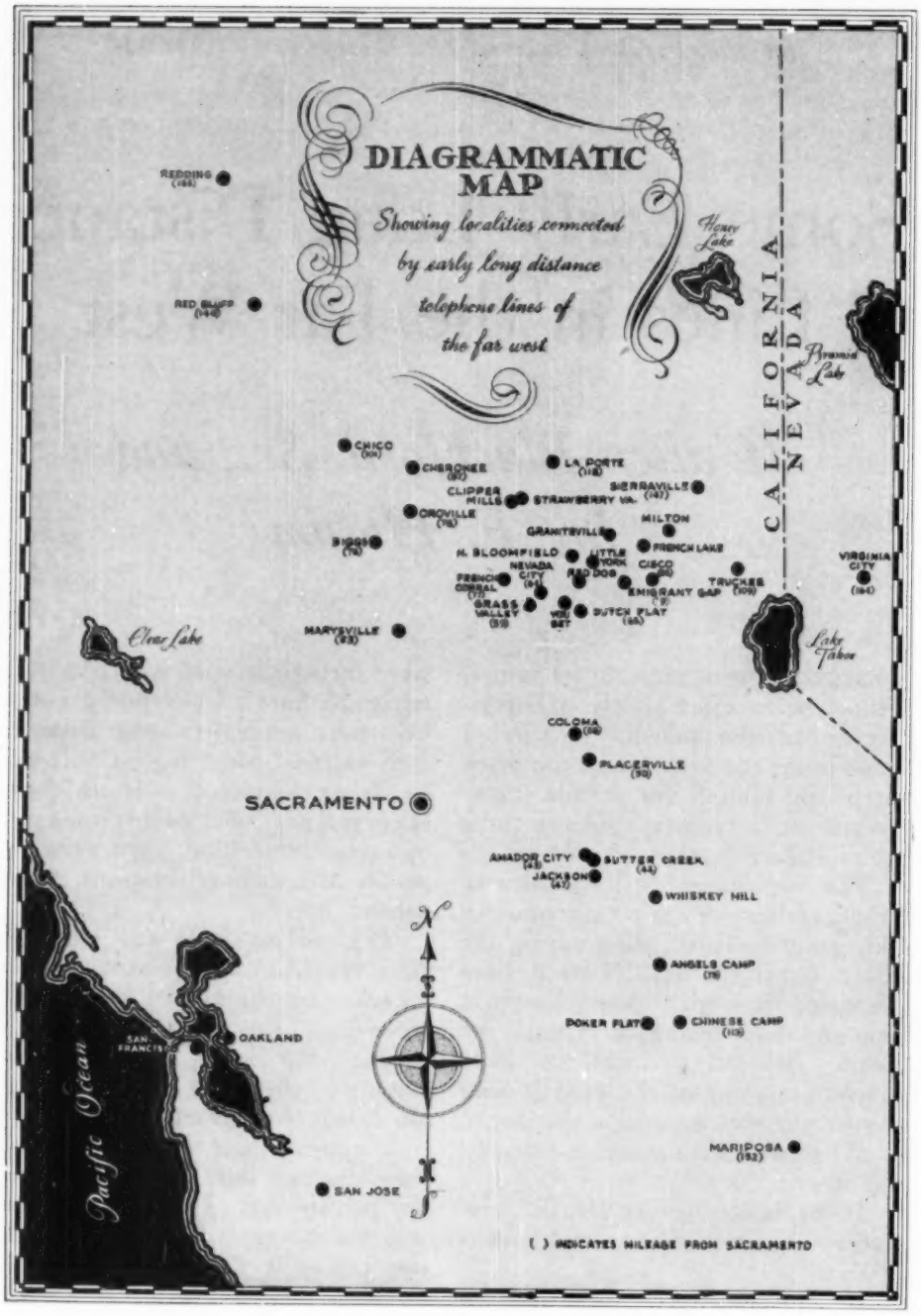
What we found makes a fascinating story.

In the days following Dr. Bell's invention of the telephone, instruments were frequently tried out on existing telegraph lines. Conversations were held over some very long distances, such as from San Diego, California, to Yuma, Arizona, over an Army telegraph line. But while these hookups were interesting, they were primarily of a demonstration or experimental nature.

The earliest *bona fide* telephone lines ran from one point to another *within* communities. True, these were cases of communication at a distance. But such intra-community lines, we believe, do not come within the category of "Long Distance."

It appears that most of the early long distance lines were constructed for private use. However, so great was the novelty of talking to someone far away that scarcely any line remained strictly private. Friends and strangers gathered at each end

* The "we" of this article represents the authors, whose interpretations and conclusions are based on the evidence to date. *W. B., Sr.*



The Mother Lode Country

to share this new wonder of the world. As the novelty wore off, various arrangements were worked out for payment of calls, where a line connected two communities or regions and there was some public traffic.

Our definition of a long distance line at the dawn of telephony, then, is one primarily constructed for the purpose of telephonic communication between distinct communities, with some public usage.

The Impact of Gold

IN 1847, only about 15,000 inhabitants were scattered over California's 400,000 square miles. Cattle raising, agriculture, and trapping were the chief occupations in the easy-going pastoral economy inherited from the Spanish and Mexican days. Then, in 1848, came James Marshall's discovery of gold at Sutter's Mill, at Coloma. Within two years the state's population catapaulted to 100,000. The peaceful life of the *hacendados* came to an abrupt halt and California began an expansion that has never stopped.

The dramatic turbulence of the first gold rush years has seldom been equaled in history. Men from nearly every country in the world swarmed over the foothills on the eastern side of California's great central valley. On the flanks of the Sierra Nevada, they dug and panned and washed for gold, brawled and gambled and dreamed of riches. They founded camps that mushroomed into roaring towns and then died overnight. They left unforgettable names scattered up and down the Mother Lode—Hangtown, Red Dog, You Bet, Whisky Hill, Poker Flat, Chinese Camp. But only a few of the '49ers found lasting wealth.

The impact of gold on the small, sleepy towns of Northern and Central California was almost beyond imagining. They boomed and boomed again, forced to telescope generations of development into a few short years. It was a rough and ready process. Small wonder that the citizens, like San Francisco's Vigilantes, had to take the law into their own hands on occasion.

But wealth kept flowing from the Mother Lode and—a little later—Nevada's fabulous Comstock on the other side of the Sierra. Trade and agriculture and transportation expanded. Diversified industries took root. Westerners soon considered their bustling cities every bit as cultured as and even more modern and progressive than those of the East.

In 1861, the first transcontinental telegraph line replaced the Pony Express. Hooking up to the developing Pacific Telegraph, it brought the West for the first time into direct contact with the rest of the nation. When the transcontinental railroad was completed, in 1869, the Pacific Coast became even more firmly linked with the East. And by 1876, the year of the telephone's birth, California's population had reached 600,000.

Mr. Bell's Invention

THAT THE PEOPLE of the West were eager to exploit anything new is exemplified by the interest they showed in the new invention. Late in 1876, Samuel Hubbard was using the San Francisco Post Office telegraph net-

work to introduce the telephone on the Pacific Coast. Immediately thereafter, the seven-mile telegraph line from the Merchants Exchange, in downtown San Francisco, to Meiggs Wharf was used to flash—via telephone—the news of ships approaching through the Golden Gate. In 1877, the practice of using telegraph lines for telephonic purposes became state-wide. Almost invariably, the public was permitted to use these circuits to satisfy its curiosity.

A variety of audible entertainment was transmitted back and forth between groups, including what was surely one of the first instances of broadcasting a public event: the evening of November 5, 1877, when three telephone instruments were placed on the stage of San Francisco's Grand Opera House, and wires were strung to five locations about the city. The opera "Mignon" and the applause of the audience were distinctly heard at all stations.

Such interest in the new invention aided the early establishment of telephone exchanges, particularly around the San Francisco Bay area. The San Francisco exchange—third in the world—went into operation February 17, 1878, with 170 subscribers. Oakland followed on April 1 of the

Hydraulic mining requires a tremendous head of water. One purpose of early telephone lines constructed in the Mother Lode country was to facilitate control of water pressure

The town of Downieville, perched along the North Fork of the Yuba River, is a typical Mother Lode community. In the days of gold, it had a population of five thousand miners

same year, and the San Jose and Sacramento exchanges were established March 1, 1879. Initially, long distance service between these points was conducted only over telegraph wires; toll line construction was not started by the Pacific Company until 1880.

Building Lines for Telephones

TELEGRAPH LINES, however, were not available to all telephone-minded people in the Far West. As it became apparent that the telephone offered tremendous advantages, not only in ordinary business transactions but particularly in far-flung mining, lumber, express, and water company operations, men began building their own telephone lines.

In Nevada, for example, the Consolidated Virginia Mine completed 1500 feet of telephone line on November 16, 1877. This mine, one of the greatest producers of all time, had thousands of feet of underground workings beneath the arid ridge on which Virginia City still stands. The telephone supplanted other electrical means of communication in such mines largely because Dr. Bell's electromagnetic telephone of that period did not require a battery and thus eliminated the possibility of explosion from an electric spark.

RIDGE TELEPHONE COMPANY. (Monthly Account)

THE CALIFORNIA ELECTRICAL WORKS,

THE GOLD AND STOCK TELEGRAPH COMPANY.

RIDGE TELEPHONE COMP Y.

Early records of the Ridge Telephone Company. From top to bottom, a page of charges for messages sent in September 1882, bills for telephone equipment bought in 1879 and 1878, and a message transmitted in 1879

This is how the main street of Dutch Flat, California, looked in 1949. The first floor of the colonnaded hotel at the left goes back to storied days, while the second building at the right, by way of contrast, houses today's telephone switchboard

By the early 1880s, networks of existing telegraph and privately constructed telephone lines linked the cities of California's central valley with the gold towns and with isolated stations far up the steep, pine-clad slopes of the Sierra. It is in this area that our search for the earliest long distance lines has been concentrated.

The production of gold had become more or less routine by the time the telephone came along. Though an occasional discovery still caused high excitement, the rush was long over. The individual prospector had been pretty much replaced by large-scale operations.

Geologically, the Mother Lode is a belt of gold-bearing quartz extending roughly a hundred miles northeast from Mariposa, near Yosemite Valley. Gold was found in many other places, however, and the Mother Lode country is popularly considered to include the Sierra slope as far north as Redding.

Over the centuries, free gold had been washed out of the quartz and into streams and rivers. Consequently, it occurred in the form of dust or nuggets nearly anywhere there was water. The '49ers found pockets of it all over the Mother Lode; they even found huge nuggets weighing several pounds. Gold that reached the larger rivers—the Bear, the American, the Yuba, the Feather—was carried down toward the valley, lodging in their wide gravel beds and alluvial deposits.

After the pockets were picked out and the riffles panned, the gold seekers had to go deeper for the values they sought. They dug out the banks and sandbars and washed the debris by means of sluice boxes with cleats on the bottom to catch the gold. But the labor involved in this

method was terrific. Then it was discovered that streams of water under pressure could wash down tons of sand and gravel in a day, and "hydraulic" mining began.

Mining at the Dawn of Telephony

THE MINING PICTURE in the Mother Lode at the dawn of telephony, then, was this: giant gold dredges chewed their way through miles of gravel in the lower riverbeds. Hard rock miners bored deep underground at Grass Valley and Nevada City, at Angel's Camp—scene of Mark Twain's celebrated Jumping Frog—and at Jackson and Sutter Creek. In the middle foothills, at the fringe of the pines, great hydraulic nozzles, or monitors, were shooting streams of water under enormous pressure against banks and ridges of sand and gravel. The water for this operation came down from dams or lakes high in the Sierra, through ditches or pipes, and gravity supplied the pressure.

Much has already been printed about the Ridge Telephone Line. It was thought for a time to have been the first long distance telephone line in the world. This line was built by the Milton, North Bloomfield, and Eureka Lake mining companies to control the water supply for hydraulic operations in and around French Corral, in Nevada County. The line ran up San Juan Ridge and continued to Milton in Sierra County, 60 miles above in the mountains. Work was started September 25, 1878, and completed on December 3 of that year.

A glimpse down a corridor of the past: the planked and roofed sidewalks of Virginia City. The present-day telephone office is in the store in the right foreground

This line, like others we shall describe, was used primarily to control the water supply coming down through miles of flumes. There was a constant starting and stopping of the stream as it was adjusted to the work at hand. The ability to sing out "Let 'er go!" to a man at a valve or dam from ten to 50

miles away brought a remarkable saving of time and water.

From well-preserved records of the Ridge Line, we know that commercial messages were handled from any of several stations along its route.

Many of the telephone lines used in controlling hydraulic mining were in operation by September 1878. Some telegraph wires were undoubtedly included in several of these telephone networks, but for the most part they were constructed for and by private enterprise. The names of some other companies give an interesting sidelight on the importance of hydraulic mining to early telephone development in this area: the South Yuba Canal Company, the Excelsior Ditch Company, the V-Flume Lumber Company.

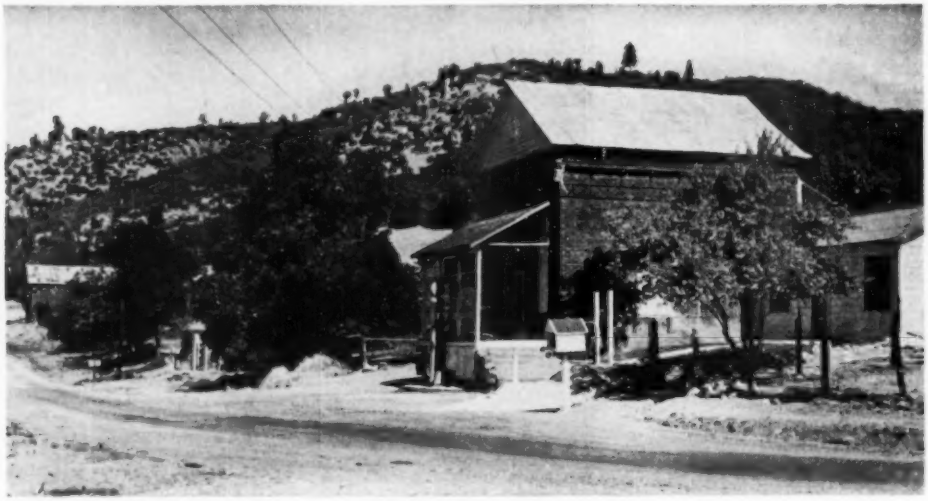
A picture of seventy-odd years ago. The "Amador Dispatch" and the telephone office were located over Henry Weil's store, in Jackson, California. William Penry, editor of the paper and an organizer of the Amador Telephone Company, stands fourth from the left on the upper porch

Some Very Early Lines

ACCORDING TO 1878 issues of the *Nevada City Transcript,* which followed telephone growth with great interest, the South Yuba Canal and affiliated companies started building 184 miles of telephone line on May 21, 1878, and completed construction on July 24, 1878. This line was started south of the South Fork of the Yuba River, and it was a sprawling system with branch lines that covered parts of two counties and touched the storied gold rush towns of Emigrant Gap and Dutch Flat.

In Amador County, not far from where gold was first discovered at Coloma, the Amador Telephone Company put a line into operation some time before June 1, 1878. This line, established on a strictly commercial basis, ran between Jackson, Sutter Creek, and the Oneida Mine. It was 25 miles long and a clear-cut example of an historical long distance line as we have defined it.

Even earlier than this, to the north, another combination of telegraph and private telephone lines had been developed. This network operated in Butte, Yuba, Tehama, and Sierra



In the foreground, in French Corral, California, is a building of the Milton Mining Company which was built in 1853. It later housed the equipment of the Ridge Telephone Company which operated the line connecting with French Lake, 58 miles away. At the extreme left is an old Wells Fargo building

counties, and was in operation by April, 1878. Several firms, including the Western Union Telegraph Company, had gone together to make up this system, too: the Sierra Flume and Lumber Company of Chico, the Rideout-Smith banking firm of Marysville, the Spring Valley Water and Gravel Company, and the Cherokee Flat gravel mines located above Oroville.

The cities of Chico, Marysville, Oroville, Biggs, Red Buff—far to the north—and Cherokee were linked by this network. By 1879, at least eleven other communities had been included, among them Sierraville, Truckee, La Porte, Clipper Mills, and Strawberry Valley. Full details about public usage on these lines are not yet known, although it has been definitely ascertained that the Rideout-Smith banking offices permitted customers to talk between their banks and to send personal messages on a limited scale.*

So, while this is our earliest long distance line so far, evidence that it completely fulfills our definition is lacking. Portions of this system obviously do—they were built for telephone purposes primarily, they permitted public usage, and they ran between distant cities. But the record is still fragmentary in parts. Until the gaps have been filled in conclusively, we are not ready to offer this line or some distinct part of

* A great deal of what we know about the telephone in the Mother Lode country must be credited to Mrs. Dorothy Irving, of the John I. Sabin Chapter of the Telephone Pioneers of America, at Sacramento. Mrs. Irving carried on her research through old newspaper files, courthouse and business records, personal and public papers. Without her hard work and persistence, this particular story might never have been told. *W. B., Sr.*

it as the earliest long distance line in the West.

Another reason is that we may have even earlier lines to tell about!

Some time prior to April, 1878, telephone service was available between several cities in the western part of Nevada. Virginia City, Sutro, Marlette Lake, Carson City and Glenbrook were connected. But information on these lines is so incomplete we can say only that we are still looking for additional data.

Is This It?

NOW, HOWEVER, we shall take you back to Nevada County again. Here, in the heart of the Mother Lode, were two communities known as Little York and Liberty Hill. Newspaper notices tell of the completion of a telephone line between the two locations, which were only six miles apart. The public participated enthusiastically in the inauguration of the new line. They talked, they listened, their eyes grew round. They congratulated one another on their chance to experience this new wonder. For a long time, they said to one another, they would remember this day. What day? January 22, 1878.

We're not saying that this was the first long distance line in the world, or even in the West. We're just saying that it's the earliest one we have found so far. And we're still looking.

Who knows but that some enterprising man built an even earlier line, that now seems as deeply buried in the past as the lost camps of Red Dog and You Bet? Maybe we'll find it!

We Call Them Outdoor Booths

THE POSTMASTER GENERAL, after consulting the Ministry of Town and Country Planning, the Royal Fine Art Commission and the Councils for the Preservation of Rural England and Wales, has decided to maintain "Post Office Red" as the standard colour for kiosks. For places of exceptional beauty one alternative colour scheme—dark battleship grey with the glazing bars picked out in red—may be adopted after consultation with the Ministry of Town and Country Planning.

Telecommunications Journal, United Kingdom Post Office

Twenty-five Years Ago in the
BELL TELEPHONE QUARTERLY

Items from Volume IV, Number 1, January 1925

An Instrumentality Of Service

EVERY NEW FEATURE of modern life has resulted in a new demand upon the telephone service. So automobiles made their demands for telephone service, so airplanes added new requirements, so radio broadcasting itself, and so every innovation. Each has had to be tied into our daily life by the wires that carry speech. It would take too long to tell of the many new kinds of telephone service which have been devised to meet changing conditions. They range from the taxicab "central" to the telephone equipment of a power farmer, from the needs of a hospital to those of the motion picture director, from the battleship to the depths of the mine.

But the greatest problems of the telephone companies are not those of new adaptations, but of tremendous growth along the lines of common usage. Growth, always impressive, is nevertheless comparatively simple in most lines of industry. If the shoe business grows, the manufacturer may enlarge his factory, or build more factories and employ a larger force. If the business of the railroad grows, it may add more cars and more tracks. In such cases fundamental inventions or changes in methods may be desirable but they do not become imperative, because of the growth of the business.

How different are the problems resulting from telephone growth. Think of the long list of inventions made necessary by the growth of a single city! A million or more telephones must all be connected so that any telephone can be reached through any other telephone. Think of the inventions which had to be made before fifteen million telephones scattered throughout every state in the Union could be connected in one system, so that anyone anywhere can talk with anyone anywhere else!

The scientists and engineers have discovered and applied the means of solving each of these many problems. All lands have been drawn upon for the raw materials. New apparatus has been developed, tested and put to use. New methods of operation have been tried and approved. Construction has been put through on a nationwide scale.

Meanwhile, there has been built up an organization of telephone men and women skilled in their work, loyal to its service.

Such is the Bell System of today, an instrument of universal communication, binding together the nation and its innumerable activities.

The Bell System not only grows with the country but it helps the country to grow. During the past year new developments have been made, resulting in better apparatus and better methods. The property used for telephone purposes has been greatly extended, and the facilities for promptly meeting the many and varied requirements for service have been steadily extended.

That it has been a good year has been due to the fine work of each company, each department and each individual. The record is one of which all may well be proud.

The new year lies before us with increasing responsibilities and correspondingly greater oportunities. Economically, it promises to be a year of better general business conditions, and consequently there should be more demand for telephone service.

New problems of every sort are sure to present themselves. But they can and will be solved. Progress will be needed along many lines but it can and will be made. There is no standing still for the Bell System, because it is a living, growing organism and the enthusiasm of each individual will give him a proud part in the results which all together will achieve.

Nowhere is there to be found a corporate organization which is entrusted with an undertaking of greater magnitude.

From an editorial statement.

Who's Who & What's What

(*Continued from page 179*)

side forces of the Plant Department, he was moved to a staff position in the office of the general plant supervisor, and was subsequently loaned to the Department of Operation and Engineering of A. T. & T. He later returned to his regular duties with the New York Company, and in 1943 he transferred permanently to the O. & E. Department, where he is an engineer in the building and equipment section of the Engineering Division.

An officer in two wars, Mr. Clark spent the years between in the commercial engineering division of the New York Telephone Company, as secretary to former President Walter S. Gifford of A. T. & T., and in the sales and servicing section of the Commercial Division of the O. & E. Department. After discharge from the Army in 1945, with the rank of major, he rejoined the sales and servicing section, where he is now concerned with communication arrangements for business customers. His most recent previous contribution to this MAGAZINE was "Public Telephones: They Serve Everybody," in the issue for Spring 1948.

THE TALE of early telephone lines in the Mother Lode country of the Pacific slope represents collaboration for fair; for not only did two members of the Pacific Telephone and Telegraph Company join in writing it, but three other members combined to produce the decorative map which sets the stage for this interesting bit of history.

WALTER BLACKFORD, SR., started work for the Pacific Telephone and Telegraph

Walter Blackford, Sr.

Joy F. Hutton

Company in 1905 as a telegraph operator at Reno, Nevada, and in 1906, after the San Francisco earthquake and fire, he manned for interminable hours the only available commercial telegraph circuit between Nevada and California. He had thereafter a long career with the Company as toll testboardman in California and Nevada cities, and was one of the first to talk across the continent over the original TC circuit. He served as senior toll testboardman at San Francisco from 1933 to 1945. In the latter year he was appointed staff assistant and made general chairman of the historical committee of George S. Ladd Chapter of the Telephone Pioneers of America and editor of its *Pioneer News Letter*.

Joy F. Hutton joined the Pacific Company in 1941 as an outside representative, and worked in several Northern California exchanges. In 1947 he was transferred to the office of the general information manager in Northern California, and became a member of the staff of the *Pacific Telephone Magazine*, handling both writing assignments and news bureau duties.

The map on page 228 had to be compiled from other maps sufficiently large in scale to include the obscure places which figured in the stirring "gold rush" events of a hundred years ago. Clifford Kay and Robert Sibbald, of the chief engineer's office, and Henry Olsen, an artist in the General Information Department, worked together to produce its happy combination of accuracy and atmosphere.

The "Transistor"

(From the *Telecommunications Journal*, United Kingdom Post Office)

In the last few months, a most important discovery has been announced by the Bell Laboratories of America. They have produced a device resembling the well known crystal detector but fitted with two cat-whiskers instead of one. The device, which has been christened a "Transistor," when connected in an appropriate circuit behaves like a thermionic valve; a weak signal applied between the crystal and one cat-whisker produces an amplified signal between the crystal and the other cat-whisker. The magnification can be of the order of a thousand times in power. Very little power is required to work it and as there is no heating required the transistor is immediately ready for use. It is small, about the size of a flash lamp bulb, and is capable of working up to ten megacycles per second (30 metres wavelength). This new discovery appears to be of outstanding importance and seems likely to affect profoundly the development of telecommunications and allied branches of engineering. . . . At the moment the transistor is a laboratory wonder and its appearance as a factory product is eagerly awaited. This discovery is a good instance of a phenomenon existing for years unobserved right under our noses. One wonders what other equally important effects are awaiting discovery by someone with sufficient curiosity to look for them.

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